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Information Analysis Center Contributions to

**DoD MILITARY FORCES, ROLES,
MISSIONS, AND FUNCTIONS
Volume III of IV**

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DoD IAC Conference
Orlando, Florida
October 7-8, 1993

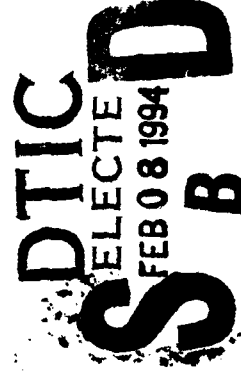
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The Tactical Warfare Simulation and Technology
Information Analysis Center

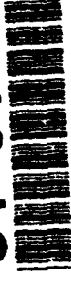
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Preface

The Department of Defense has established the DoD Information Analysis Centers (IAC) program as part of the DoD Scientific and Technical Information Program. IACs exist to assist users in making best use or application of existing scientific, technical and related information. In so doing, the 23 chartered DoD IACs and the Service or Component sponsored information centers save scarce DoD scientific and technical resources, prevent unnecessary duplication of effort among DoD components, and provide additional technical assistance to DoD components, other U.S. Government agencies and departments, their contractors, and other qualified users. The table on the following pages lists the Information Centers and the Point of Contact for each one.

This volume summarizes in unclassified unlimited distribution format, work performed by DoD Information Analysis Centers for DoD or other U.S. Government sponsors which has application over and beyond the immediate requirement to which the IACs responded. Readers are advised that much of the specific work, the resulting data, and interim or final reports described herein may be classified or otherwise withheld from general distribution in accordance with appropriate statute and/or DoD regulations. On balance, however, it is appropriate that DoD IACs share with their broadest user communities the results of data and information collection efforts, efforts to maintain and develop analytical tools and techniques, and the results of detailed studies and analyses of scientific, technical and related problems. These results are often applicable to problems which extend beyond the narrow focus of DoD, and can be described in terms that compromise no classified or sensitive information.

The DoD IAC Program has access to DoD's investment in science and technology spanning the past 40 years. It has access to the analytical tools and techniques which DoD has used to assess this information. The scientific and technical challenges facing the nation go well beyond the boundaries of the DoD IAC Program; the efforts of DoD IACs described at least in part in this volume illustrate the potential contributions IACS could make. Potential users, inside or outside the executive branch of the U.S. Government are encouraged to contact IACs of interest or the DoD IAC Program Management Office to obtain additional assistance or to make use of the knowledge and skills resident within this program.

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INFORMATION CENTERS

| DoD Information Analysis Centers | | |
|----------------------------------|--|--|
| APMIAC | Airfields, Pavements and Mobility Information Analysis Center | Mr. Gerald Turnage Phone: (601) 634-2734 |
| CBIAC | Chemical Warfare/Chemical and Biological Defense Information Analysis Center | Mr. James J. McNeely Phone: (410) 676-9030 E-Mail: ijmcneel@im.battelle.org |
| CEIAC | Coastal Engineering Information Analysis Center | Dr. Fred Camfield Phone: (601) 634-2012 E-Mail: camfield@coafs1.wes.army.mil |
| CIAC | Ceramics Information Analysis Center | Dr. C. Y. Ho Phone: (317) 494-9393 Dr. Said K. El-Rahaiby Phone: (317) 494-9393 E-Mail: rahaiby@ecn.purdue.edu |
| CPIA | Chemical Propulsion Information Agency | Mr. Thomas W. Christian Phone: (410) 992-7300 E-Mail: cpial_tc@jhunix.hcs.jhu.edu |
| CRSTIAC | Cold Regions Science and Technology Information Analysis Center | Ms. Nancy Liston Phone: (603) 646-4221 E-Mail: nliston@hanover-crrl.army.mil |
| CSERIAC | Crew System Ergonomics Information Analysis Center | Dr. Lawrence D. Howell Phone: (513) 255-4842 E-Mail: lhowell@falcon.aamrl.wpafb.af.mil |
| CTIAC | Concrete Technology Information Analysis Center | Phone: (601) 634-3264 |

DoD Information Analysis Centers (Continued)

| | | |
|--------|--|--|
| DACS | Data and Analysis Center for Software | Mr. Dennis J. Wesolowski Phone: (315) 734-3696 E-Mail: dennisw@kaman.com |
| DASIAC | DoD Nuclear Information and Analysis Center | Phone: (703) 329-7123 E-Mail: claire-watson@bob.kaman.com |
| GACIAC | Guidance and Control Information Analysis Center | Dr. Robert J. Heaston Phone: (312) 567-4519 E-Mail: rheaston@dgis.dtic.dla.mil |
| HEIAC | Hydraulic Engineering Information Analysis Center | Phone: (601) 634-2608 |
| HTMIAC | High Temperature Materials Information Analysis Center | Dr. C. Y. Ho (317) 494-9393 Dr. Ronald H. Bogaard Phone: (317) 494-9393 E-Mail: bogaard@ecn.purdue.edu |
| IRIA | Infrared Information Analysis Center | Dr. Rodney C. Anderson Phone: (313) 994-1200, Ext. 2725 E-Mail: anderson@erim.org |
| MIAC | Metals Information Analysis Center | Dr. C. Y. Ho Phone: (317) 494-9393 Dr. Pramod D. Desai Phone: (317) 494-9393 E-Mail: desaip@ecn.purdue.edu |
| MMCIAC | Metal Matrix Composites Information Analysis Center | Dr. C. Y. Ho Phone: (317) 494-9393 E-Mail: hocy@ecn.purdue.edu Dr. Harvey M. Berkowitz Phone: (317) 494-9393 |

DoD Information Analysis Centers (Continued)

| | | |
|-----------------|--|---|
| MTIAC | Manufacturing Technology Information Analysis Center | Ms. Michal Safar Phone: (312) 567-4733 E-Mail: msafar@dgis.dtic.dla.mil |
| NTIAC | Nondestructive Testing Information Analysis Center | Dr. George A. Matzkanin Phone: (512) 263-2106 E-Mail: ntiac@access.texas.gov |
| PLASTECH | Plastics Technical Evaluation Center | Mr. Charles Yearwood Phone: (201) 724-4222 E-Mail: yearwood@pica.army.mil |
| RAC | Reliability Analysis Center | Mr. Preston MacDiarmid Phone: (315) 337-0900 E-Mail: rac@mail.itri.com |
| SMIAC | Soil Mechanics Information and Analysis Center | Mr. David R. Haulman Phone: (601) 634-3376 |
| SURVIAC | Survivability/Vulnerability Information Analysis Center | Mr. John Vice Phone: (513) 255-4840 E-Mail: vice@isi.edu |
| TWSTIAC | Tactical Warfare Simulation and Technology Information Analysis Center | Dr. Larry W. Williams Phone: (614) 424-5047 E-Mail: williaml@battelle.org Mr. Ernie Smart (Distributed Interactive Simulation) Phone: (407) 658-5014 E-Mail: esmart@dmso.dtic.dla.mil |

| Service Sponsored Information Centers | | |
|---------------------------------------|--|--|
| SAVIAC | Shock and Vibration Information Analysis Center | Mr. Hal Kohn Phone: (703) 412-7856 E-Mail: kohn@ccity.ads.com |
| ASIAC | Aerospace Structures Information and Analysis Center | Mr. Gordon Negaard Phone: (513) 255-6688 E-Mail: asiac@sltrvc1.flight.wpafb.af.mil |
| SIDAC | Supportability Investment Decision Analysis Center | Mr. Kevin Deal Phone: (513) 258-6711 E-Mail: kdeal@bclcl1 |

Foreword to Volume III

Enactment of the Goldwater-Nichols Department of Defense Reorganization Act of 1986 refocused DoD military system acquisition efforts on the military requirements of operating forces. The Commanders-in-Chief of the Unified and Specified Commands have significant responsibilities for the development and establishment of requirements for future military systems. These requirements are to be met by the Military Services and other DoD Components. These requirements may focus on broad capabilities to be achieved by strategic nuclear forces, ground forces, naval forces, tactical air forces, and Special Operations Forces. They may also be viewed from a functional perspective to include training, communications, intelligence, maintenance and logistics, arms control, and even defense conversion and dual-use functions.

The DoD Information Analysis Centers (IAC) Program oversees 23 IACs and sponsors 15 contractor operated IACs. This volume describes work completed by DoD IACs over the past 24 months relevant to forces operated by the Unified and Specified Commands within a framework of forces, roles and missions, or DoD functions.

As noted in the Preface, much of the work completed is not generally available outside the Department of Defense or the U.S. Government. The raw data, the reduced data, and the analytical techniques used to collect or assess such information may be available. Interested readers are encouraged to contact the IAC reporting results of interest and/or the DoD IAC Program Management Office for additional information.

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| The DoD Information Analysis Center (IAC) Program | | Presented by: Dr. Forrest R. Frank |
| DoD S&T Thrusts (Each thrust is in a separate section. Each section begins with a blue divider page.) | | |
| Thrust | IAC | Presentation |
| Global Surveillance & Communications | GACIAC | Strategic Forces and Missions |
| | HTMIAC | Inquiry Response Related to Global Surveillance |
| | IRIA | Air Superiority and Global Surveillance: Shipboard Infrared Search and Track Sensors |
| | TWSTIAC | Assessment of Ultra-Wideband (UWB) Radar Technology |
| | CRSTIAC | Observations of Acoustic Surface Waves Propagating Above a Snow Cover |
| Precision Strike | CRSTIAC | Smart Weapons Operability Enhancement (SWOE) Program |
| | GACIAC | Precision Strike |
| | GACIAC | Sensors and Electronic Devices |
| | IRIA | Sensors and Electronic Devices: Multispectral Detection |
| | TWSTIAC | Generic Sensor Package S&T Assessment for the Office of Naval Research |
| | TWSTIAC | Assessment of Ultra-Wideband (UWB) Radar Technology |

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| DoD S&T Thrusts | | |
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| (Each thrust is in a separate section. Each section begins with a blue divider page.) | | |
| Thrust | IAC | Presentation |
| Air Superiority and Defense | CPIA | Literature Searches: A Series of CPIA Core Products Directed to the DoD Thrust on Air Superiority |
| | IRIA | Air Superiority and Global Surveillance: Shipboard Infrared Search and Track Sensors |
| | SURVIAC | The Joint Live Fire/Live Fire Test (JLF/LFT) Program Catalogue |
| | SURVIAC | U.S. Air Force Surface-to-Air Engagements During Operation Desert Storm |
| | TWSTIAC | Analysis of Effects of New Weapons Systems in the Employment of Tactical Air Forces |
| | TWSTIAC | Assessment of Ultra-Wideband (UWB) Radar Technology |
| | CBIAC | Evaluation of Feasibility of a Biological Agent Detection Concept |
| Sea Control and Undersea Superiority | CBIAC | Interactive Decision Training Scenario for USN Damage Control and CBR-D Decision Training |
| | CRSTIAC | Ship Superstructure Icing |
| | TWSTIAC | Mission Analysis of Future Enhanced Survivability Ship Platforms |

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| Advanced Land Combat | CBIAC | Bio Technology: A Survey of Seven Technologies to Identify Clostridium Botulinum and Bacillus Anthracis |
| | CBIAC | Evaluation of Lightweight Integrated Suit Technologies (LIST) and Associated Test Methods |
| | GACIAC | Advanced Land Combat |
| | GACIAC | Tactical Land Forces |
| | NTIAC | Nondestructive Evaluation Applications for Strategic Forces and Missions |
| | NTIAC | Nondestructive Test/Evaluation Assessment in Support of Tactical Land Forces and Missions |
| | SURVIAC | The Joint Live Fire/Live Fire Test (JLF/LFT) Program Catalogue |
| | SURVIAC | Survivability Systems Master Plan |
| | TWSTIAC | A Notional Individual Fighting System |
| | TWSTIAC | Evaluation of Candidate Warheads Against Chemical Targets for Patriot PAC-3 |
| | TWSTIAC | TWSTIAC Casualty Reduction Modeling for the Natick R&D Center |

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| (Each thrust is in a separate section. Each section begins with a blue divider page.) | | |
| Thrust | IAC | Presentation |
| Synthetic Environments | CBIAC | Chemical Warfare Counter Proliferation Computerized Decision Aid |
| | CRSTIAC | Decision and Analysis of a Low Speed Drag Plow for Deep Snow |
| | CRSTIAC | Observations of Acoustic Surface Waves Propagating Above a Snow Cover |
| | CRSTIAC | Ship Superstructure Icing |
| | CRSTIAC | Smart Weapons Operability Enhancement (SWOE) Program |
| | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Human Factors in the Design of Synthetic Environments |
| | TWSTIAC | TWSTIAC Casualty Reduction Modeling for the Natick RD&E Center |
| | TWSTIAC | Computers & Software Communications Networking |
| | TWSTIAC | Synthetic Environment |

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| (Each thrust is in a separate section. Each section begins with a blue divider page.) | | |
| Thrust | IAC | Presentation |
| Technology for Affordability | CBIAC | Chemical Warfare Counter Proliferation Computerized Decision Aid |
| | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Integrated Maintenance Information System (IMIS): Defined |
| | DACS | DACS Technical Reports |
| | DACS | Open Architecture Systems for Process Automation (OASYS) |
| | MTIAC | MTIAC Directory of Manufacturing Research Centers |
| | MTIAC | Army Strategic ManTech Plan Workshop and Minutes |
| | MTIAC | Rapid Prototyping MTIAC State-of-the-Art-Report |
| | NTIAC | Nondestructive/Non-Intrusive Sensors for Manufacturing Process Control |
| | RAC | Concurrent Engineering Series |
| | RAC | Total Quality Management (TQM) Toolkit |
| | SURVIAC | Computer-Based Aircraft Wiring Maintenance Aid |

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| Technology | IAC | Presentation |
| Computers | CBIAC | MEDTAG Concept Evaluation and Prototype Development Plan |
| | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Computer-Aided Systems Human Engineering (CASHE) |
| | DACS | DACS Technical Reports |
| | DACS | Open Architecture Systems For Process Automation (OASYS) |
| | TWSTIAC | TWSTIAC Support to Development of a Networked CD-ROM Database |
| Software | TWSTIAC | Computers & Software Communications Networking |
| | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Advanced Human System Interface Design in Control Rooms |
| | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Human Factors in the Design of Synthetic Environments |

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| | DACS | Open Architecture Systems for Process Automation (OASYS) |
| Sensors | CBIAC | Bio Technology: A Survey of Seven Technologies to Identify Clostridium Botulinum and Bacillus Anthracis |
| | GACIAC | Sensors and Electronic Devices |
| | IRIA | Sensors and Electronic Devices: Multispectral Detection |
| | IRIA | Strategic Forces and Arms Control: Infrared Signature Computer Codes |
| | IRIA | Sensors and Electronic Devices: Infrared and Electro-Optical Systems Handbook |
| | IRIA | Sensors and Electronic Devices: Infrared Data Bases |
| | RAC | Reliable Application of Components Series |
| | TWSTIAC | Generic Sensor Package S&T Assessment for the Office of Naval Research |
| | TWSTIAC | Assessment of Ultra-Wideband (UWB) Radar Technology |

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| Technology | IAC | Presentation |
| Communications Networking | TWSTIAC | TWSTIAC Support to Development of a Networked CD-ROM Database |
| | TWSTIAC | Computers & Software Communications Networking |
| Electronic Devices | GACIAC | Sensors and Electronic Devices |
| | IRIA | Sensors and Electronic Devices: Multispectral Detection |
| | RAC | Failure Mode/Mechanism Distributions |
| | RAC | Time Stress Measurement Device (TSMD) |
| Environmental Effects | CBIAC | Bio Technology: A Survey of Seven Technologies to Identify Clostridium Botulinum and Bacillus Anthracis |
| | CRSTIAC | Design and Analysis of a Low Speed Drag Flow for Deep Snow |
| | CRSTIAC | Observations of Acoustic Surface Waves Propagating Above a Snow Cover |
| | CRSTIAC | Ship Superstructure Icing |
| | CRSTIAC | Smart Weapons Operability Enhancement (SWOE) Program |
| | CRSTIAC | Waterfowl Mortality in Eagle River Flats, Alaska |

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| Environmental Effects (Continued) | HEIAC | Dam Break Analyses |
| Materials and Processes | APMIAC | Facilities Engineering Applications Program (FEAP) |
| | CIAC | Advanced Materials and Processing Technology Workshop and Proceedings |
| | CIAC | Assessment of the Status of Ceramic Matrix Composites Technology in the United States and Abroad |
| | HTMIAC | High Temperature Materials Properties Online Numeric Database Capability for Dual-Use Technology Transfer |
| | HTMIAC | Database on Laser-Induced Damage Threshold for Strategic Forces and Missions |
| | MIAC | Computerization of Properties of Austempered Ductile Iron (ADI) |
| | MIAC | Corrosion in DoD Systems: Data Collection and Analysis |
| | MMCIAC | Engineered Materials Briefing at the Capital Metals and Materials Forum |
| | MMCIAC | Bibliographies Prepared for Various DoD Small Business Innovative Research (SBIR) Program Solicitation Topics |

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| | NTIAC | Critical DoD Advanced Materials: Scientific and Technical Information Analysis |
| | NTIAC | Quantitative Nondestructive Evaluation (NDE) Data Book |
| Energy Storage | CPIA | Rocket Motor Manual: One of CPIA's Standard Manuals Directed to the Key DoD Technology on Energy Storage |
| Propulsion and Energy Conversion | CPIA | Explosive Ingredients Sources Database (EISD): A CPIA Technical Area Task Applied to Naval Surface Sea Control |
| | CPIA | Chemical Propulsion Technology Reviews: A Series of CPIA Core Products Directed to the Key DoD Technology on Propulsion and Energy Conversion |
| Design Automation | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Advanced Human System Interface Design in Control Rooms |
| | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Computer-Aided Systems Human Engineering (CASHE) |
| | MTIAC | Rapid Prototyping MTIAC State-of-the-Art-Report |

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| Human System Interfaces | CBIAC | Evaluation of Lightweight Integrated Suit Technologies (LIST) and Associated Test Methods |
| | CBIAC | Interactive Decision Training Scenario for USN Damage Control and CBR-D Decision Training |
| | CBIAC | MEDTAG Concept Evaluation and Prototype Development Plan |
| | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Advanced Human System Interface Design in Control Rooms |
| | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Human Factors Issue in Personnel Training: Potpourri |
| | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Human Factors in the Design of Synthetic Environments |
| | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services --State-of-the-Art Human Factors Technical Information |

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| Human System Interfaces (Continued) | MTIAC | Academic Apparel Research Technical Support and Products for DLA |
| | TWSTIAC | A Notional Individual Fighting System |

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| Military Force, Role, Mission, & Function | IAC | Presentation |
| Strategic Nuclear Forces | HTMIAC | Database on Laser-Induced Damage Threshold for Strategic Forces and Missions |
| | IRIA | Strategic Forces and Arms Control: Infrared Signature Computer Codes |
| | TWSTIAC | Assessment of Ultra-Wideband (UWB) Radar Technology |
| | CBIAC | Interactive Decision Training Scenario for USN Damage Control and CBR-D Decision Training |
| Tactical Air Forces | CRSTIAC | Smart Weapons Operability Enhancement (SWOE) Program |
| | GACIAC | Precision Strike |
| | RAC | Service Life Extension Assessment |
| | SURVIAC | U.S. Air Force Surface-to-Air Engagements During Operation Desert Storm |

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| Naval Forces | CRSTIAC | Ship Superstructure Icing |
| | MIAC | Failure Analysis on Electroding Remelt (ESR) 4340 Steel |
| | RAC | Service Life Extension Assessment |
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| | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Integrated Maintenance Information System (IMIS): Defined |
| | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Human Factors in the Design of Synthetic Environments |
| | DACS | Open Architecture Systems for Process Automation (OASYS) |
| | MTIAC | Academic Apparel Research Technical Support and Products for DLA |
| | NTIAC | Quantitative Nondestructive Evaluation (NDE) Data Book |

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| | CBIAC | Chemical Warfare Counter Proliferation Computerized Decision Aid |
| | CBIAC | Commercial Products From Demilitarization Operations |
| | IRIA | Strategic Forces and Arms Control: Infrared Signature Computer Codes |
| | IRIA | Strategic Forces and Arms Control: "Open Skies" Support |
| Dual Use | CBIAC | Bio Technology: A Survey of Seven Technologies to Identify Clostridium Botulinum and Bacillus Anthracis |
| | CBIAC | Chemical Warfare Counter Proliferation Computerized Decision Aid |
| | CBIAC | Commercial Products From Demilitarization Operations |
| | CRSTIAC | Waterfowl Mortality in Eagle River Flats, Alaska |

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(Continued)

| DoD Military Forces, Roles, Missions, and Functions Each Military Force, Role, Mission and Function is in a separate section. Each section begins with a blue divider page. | | |
|--|----------------|--|
| Military Force, Role, Mission, & Function | IAC | Presentation |
| Dual Use (Continued) | CSERIAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Advanced Human System Interface Design in Control Rooms |
| | CSERAC | Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Integrated Maintenance Information system (IMIS): Defined |
| | DACS | DACS Technical Reports |
| | DACS | Open Architecture Systems for Process Automation (OASYS) |
| | HEIAC | Dam Break Analyses |
| | HTMIAC | High Temperature Materials Properties Online Numeric Database Capability for Dual-Use Technology Transfer |
| | NTIAC | Nondestructive/Non-Intrusive Sensors for Manufacturing Process Control |
| | RAC | Concurrent Engineering Series |
| | | |

CONTENTS

Volume IV of IV

This compilation is Limited Distribution, therefore, not all attendees will receive this volume.

Product Listings

This compilation lists products from the IACs in the following sequence: those that are relevant to the DoD S&T Thrusts, the Key Technologies, and Military Forces, Roles, Missions, and Functions. Each product is described in terms of: IAC Product Identification Number, Primary Author Name(s), Title, Publication Date, and Available From. Registered users can acquire documents having AD Numbers from the Defense Technical Information Center (DTIC). Please contact the particular IAC to determine the availability of documents which do not have AD Numbers.

CBIAC

CIAC

CPIA

CSERIAC

DACS

HEIAC

HTMIAC

IRIA

MIAC

MMCIAC

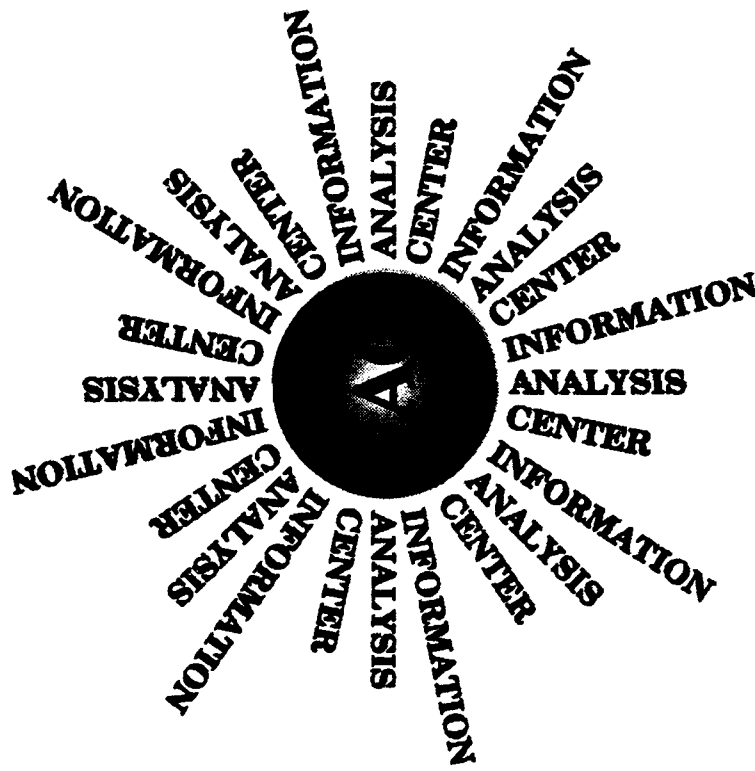
RAC

SURVIAC

TWSTIAC

DoD INFORMATION ANALYSIS CENTER (IAC) PROGRAM

DoD Information Analysis Center (IAC) Program



Presentation by:
Forrest R. Frank
Program Manager, DoD IAC Program

DTIC

Defense Technical Information Center • IAC Program

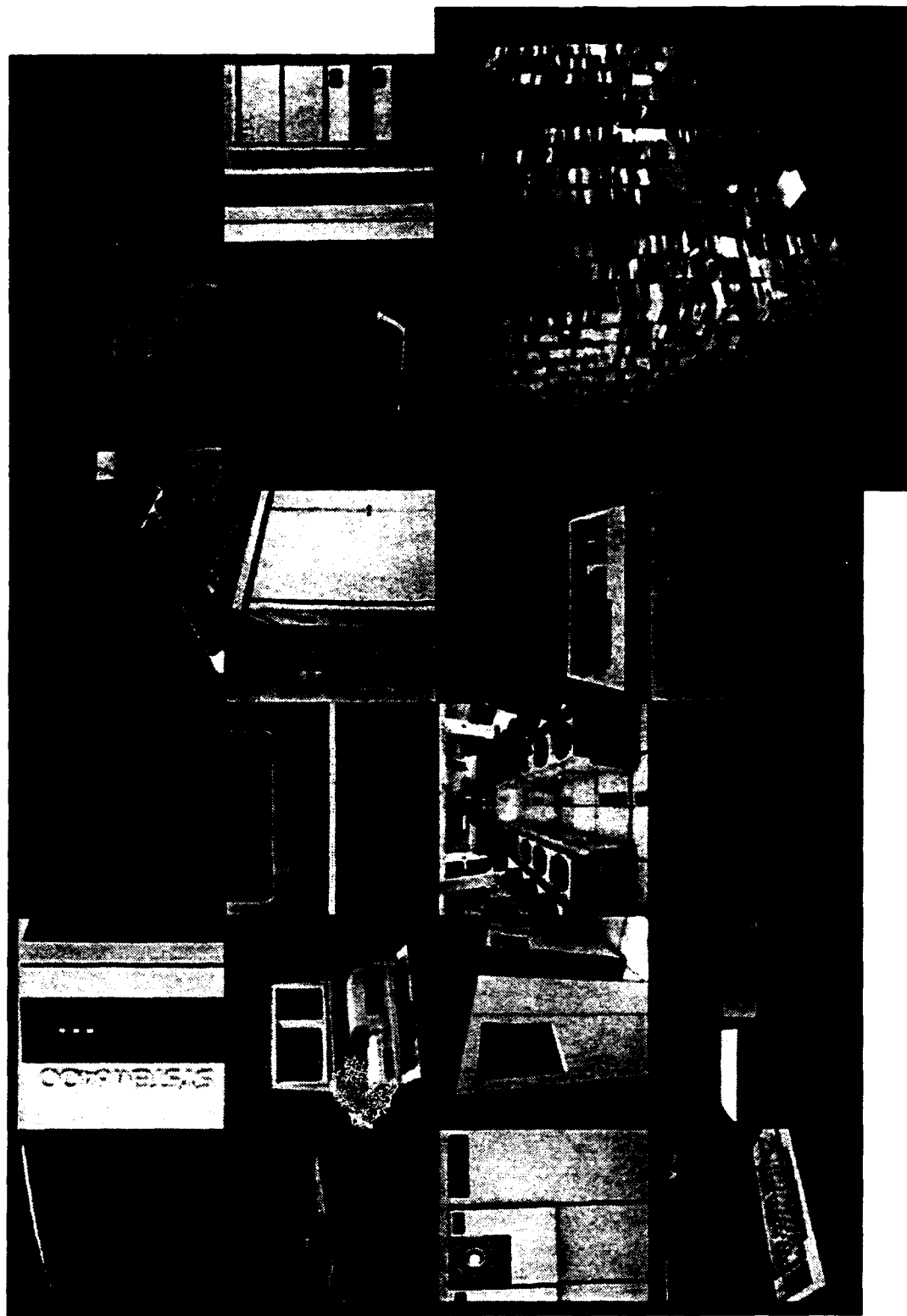
DoD Information Analysis Center (IAC) Program



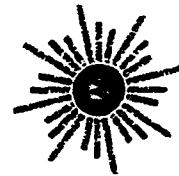
DTIC

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Extraneous Information



Information Overload



- **Identify Relevant Data**
- **Reduce Relevant Data to Information**
- **Identify and Employ Appropriate Analytical Tools and Techniques**

DTIC

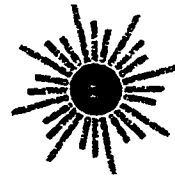
Defense Technical Information Center • IAC Program

Can It Be This Simple Again?



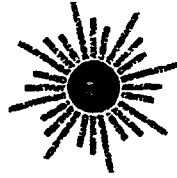
Briefing Overview

- **Mission of IACs**
- **Authority**
- **IAC Functions**
- **IAC Operations**
- **IAC Products and Services**
- **Subject-Matter Coverage**
- **Using DoD IACs**
- **Benefits of IACs**



Authority

- **Formal Organization Chartered by DoD
 - DoD Regulation 3200.12-R-2**
- **Staffed by Technical Experts**
- **Co-Located Laboratories and/or Other Technical Activities**
- **Collect and Disseminate Scientific and Technical Information**
- **Provide STINFO Support to DoD, Other U.S. Government Agencies, and Other Authorized Users**



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DoD Operates 23 IACs



DoD IACs - Some Examples

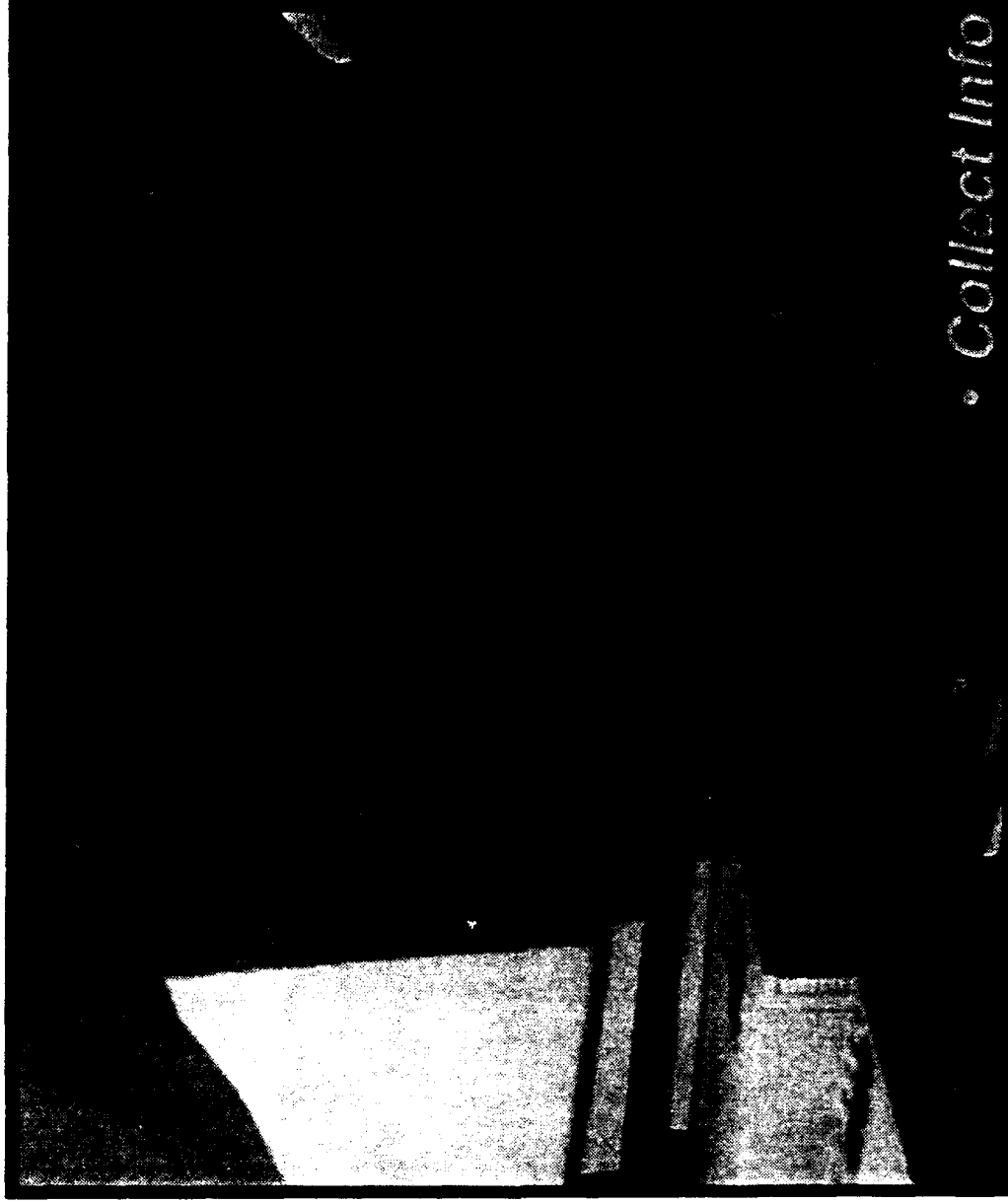
- **CSERIAC**
**Crew System Ergonomics
Information Analysis Center**
- **DACS**
**Data and Analysis Center for
Software**
- **MTIAC**
**Manufacturing Technology
Information Analysis Center**
- **NTIAC**
**Nondestructive Testing
Information Analysis Center**
- **SURVIAC**
**Survivability/Vulnerability
Information Analysis Center**



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Worldwide Information



***Collect Information on
a Worldwide Basis***



IAC Functions - User Perspective

- **Answer Questions**
 - **Referrals**
 - **Bibliographic Inquiries**
 - **Techniques and Methods**
 - **Data Analysis**
 - **Current Awareness**
- **Provide Advice**
 - **Technical Advisory Services**
 - **Technical Transfer**
 - **Studies and Analyses**
 - **Symposia, Conferences, Workshops**



IAC Operations

- **Information Collection**
 - **Discipline and/or Mission Focus**
 - **Domestic and International**
 - **All Media**
 - **Classified/Unclassified**
 - **Limited/Unlimited Distribution**
- **Information Storage and Retrieval**
- **Information Synthesis and Analysis**
 - **Analytical Tools and Techniques**
 - **Studies and Analyses**
- **Information Dissemination**



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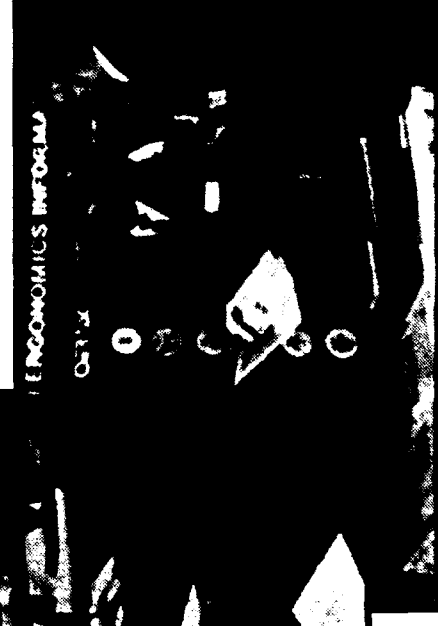
IAC Information Products and Services

- **IAC Products**
- **Reference Tools (Handbooks, Data Books, etc.)**
- **Models and Simulations**
- **Standards and Specifications**
- **Studies and Analyses**



IAC Information Products and Services

- **Technical Information Services**
- **Referrals**
- **Bibliographic and Technical Inquiries**
- **Advice**
- **Program and Project Support (per CAAS Directive)**



Subject-Matter Coverage



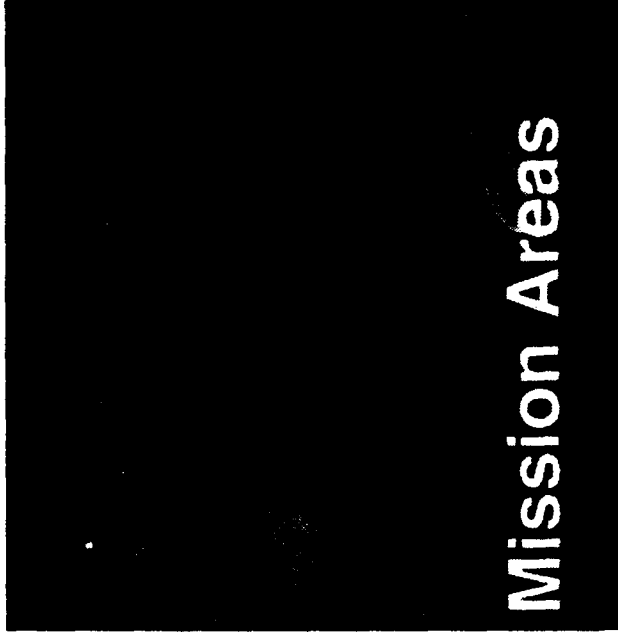
Three Taxonomies



• **Military Forces and**

• **Key Technologies**

• **Science and Technology Thrusts**



Mission Areas



DoD Missions and Functional Areas

| DoD Missions and Functional Areas Selected IACs | Nuclear Forces | Ground Forces | Naval Forces | Tactical Air Forces | SOF | Intelligence | Communications | Logistics | Training | Historical |
|--|----------------|---------------|--------------|---------------------|-----|--------------|----------------|-----------|----------|------------|
| CBIAC | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| CIAC | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| CSERIAC | | ✓ | ✓ | ✓ | | | | | ✓ | |
| GACIAC | ✓ | ✓ | ✓ | ✓ | | ✓ | | | ✓ | |
| HTMIAC | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | |
| MIAC | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | |
| MMCIAC | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | |
| MTIAC | | | | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| NTIAC | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | |
| SURVIAC | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| TWSTIAC | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |



IACs and Key Technologies

| Technology Interest of Potential User Selected IACs | Computers | Software | Sensors | Communi- cation Networking | Electronic Devices | Environmental Effects |
|--|-----------|----------|---------|----------------------------------|-----------------------|--------------------------|
| CBIAC | ✓ | | ✓ | | ✓ | ✓ |
| CIAC | | | ✓ | | ✓ | |
| CSERIAC | ✓ | | | ✓ | ✓ | |
| GACIAC | | ✓ | ✓ | | ✓ | ✓ |
| HTMIAC | | ✓ | ✓ | | ✓ | ✓ |
| MIAC | | | | | | ✓ |
| MMCIAC | | | | | | ✓ |
| MTIAC | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| NTIAC | ✓ | | ✓ | | | |
| SURVIAC | | ✓ | ✓ | | ✓ | |
| TWSTIAC | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |



IACs and Key Technologies

| Technology Interest of Potential User Selected IACs | Materials and Processes | Energy Storage | Propulsion and Energy Conversion | Design Automation | Human System Interfaces |
|--|-------------------------------|-------------------|--|----------------------|-------------------------------|
| CBIAC | | | | | ✓ |
| CIAC | ✓ | | ✓ | | |
| CSERIAC | | | | ✓ | ✓ |
| GACIAC | ✓ | ✓ | ✓ | ✓ | |
| HTMIAC | ✓ | | ✓ | | |
| MIAC | ✓ | | ✓ | | |
| MMCIAC | ✓ | ✓ | ✓ | ✓ | ✓ |
| MTIAC | ✓ | | | | ✓ |
| NTIAC | ✓ | | | | ✓ |
| SURVIAC | ✓ | ✓ | ✓ | ✓ | ✓ |
| TWSTIAC | ✓ | ✓ | ✓ | ✓ | ✓ |



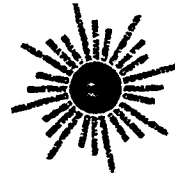
IACs and Science and Technology Thrusts

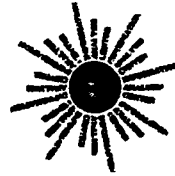
| Science and Tech Thrust of User | Global Surveillance | Precision Strike | Air Superiority and Defense | Sea Control/Undersea Superiority | Advanced Land Combat | Synthetic Environments | Technology Priority |
|---------------------------------|---------------------|------------------|-----------------------------|----------------------------------|----------------------|------------------------|---------------------|
| Selected IACs | | | | | | | |
| CBIAC | | | | | ✓ | | |
| CIAC | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| CSERIAC | | | ✓ | ✓ | ✓ | | ✓ |
| GACIAC | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| HTMIAC | | ✓ | | | ✓ | | ✓ |
| MIAC | | | ✓ | ✓ | ✓ | | |
| MMCIAC | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| MTIAC | | | | | | | ✓ |
| NTIAC | | | | ✓ | ✓ | ✓ | ✓ |
| SURVIAC | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| TWSTIAC | | ✓ | | | ✓ | ✓ | |



Using DoD IACs

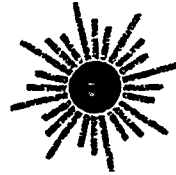
- **Basic Services**
 - Call, Write, Visit
 - Direct Contact with IAC
 - No or Minimal Charge
- **Extended Basic Services**
 - Direct Contact with IAC and COTR
 - Negotiated Fee for Service
- **Technical Area Tasks (TATs)**
 - Extensive Contact with IAC and COTR
 - Separate Funding and Contract Modification
 - Review and Approval by IAC Program
 - Management Office (PMO)



Who To Contact**Defense Technical Information Center****Attn: DTIC-AI****Cameron Station****Alexandria, VA 22304-6145****Phone: (703) 274-6260 or DSN 284-6260****Fax: (703) 274-0980 or DSN 284-0980****Electronic Mail: f frank@dtic.dla.mil**

IAC Benefits

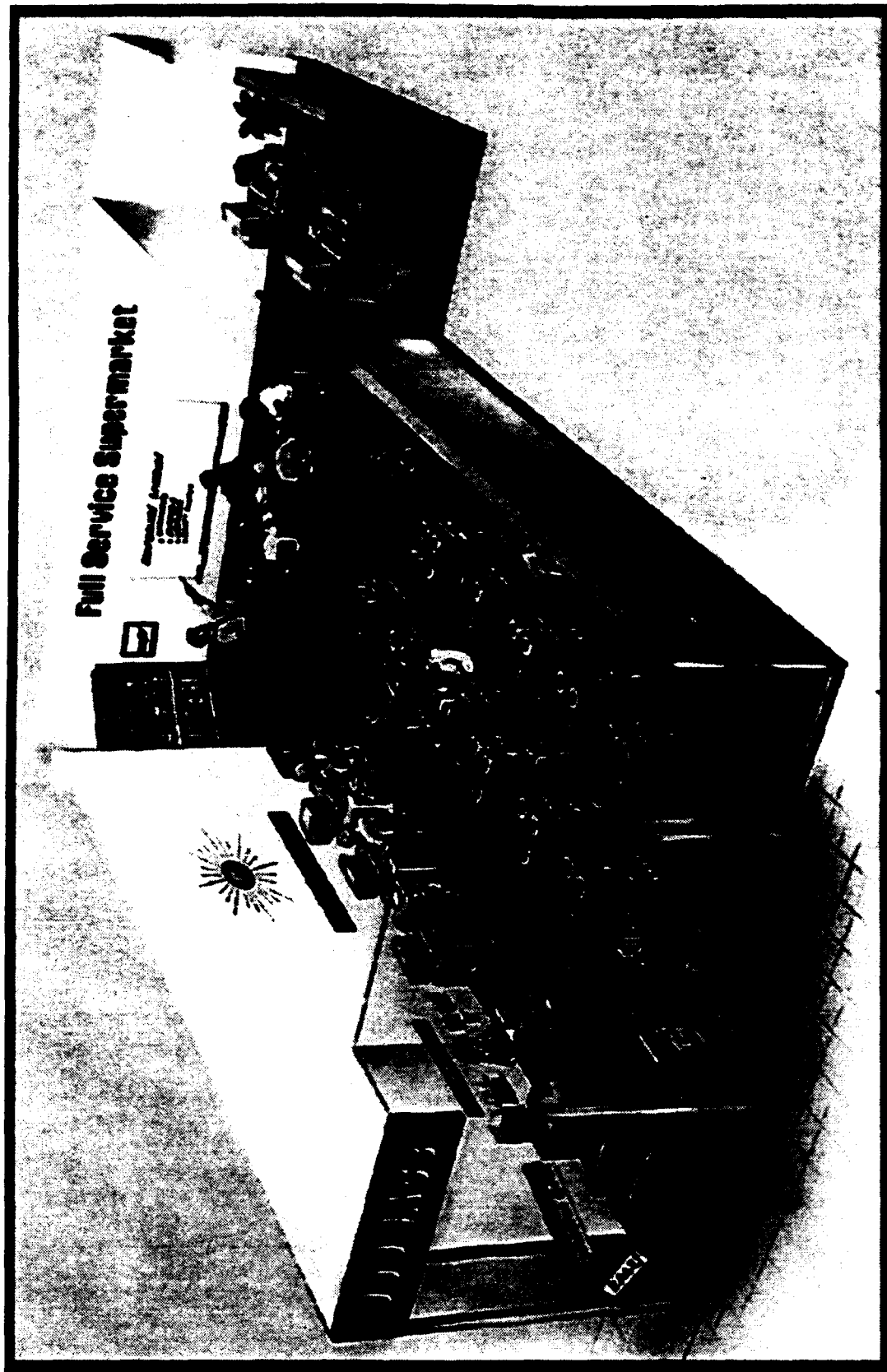
- **Quantitative Benefits**
 - **Value Engineering Analysis**
 - **Cost Avoidance**
 - **Direct Savings**
- **Qualitative Benefits**
 - **Improvements in Operational Capability**
 - **Objective Answers to Enhance User Confidence in Existing Data and Information**
 - **Standards and Specifications for Normalization of Data and Methods Used Elsewhere**



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DoD IAC Full-Service Supermarket



STRATEGIC NUCLEAR FORCES

DATABASE ON LASER-INDUCED DAMAGE THRESHOLD FOR STRATEGIC FORCES AND MISSIONS

Prepared by

**Ronald H. Bogaard
High Temperature Materials Information Analysis Center
CINDAS/Purdue University
2595 Yeager Road
West Lafayette, IN 47906-1398**

Approved for Public Release; Distribution is Unlimited

CONTEXT

- **SUPPORT TO:**
 - **DoD Military Mission/Function**
 - o **Strategic Forces: Detection and Warning**
 - o **DoD Missions: Dual Use and Technology Transfer**
 - **DoD Key Technology Area**
 - o **Sensors**
 - o **Materials and Processes**
 - **DoD Science and Technology Thrust**
 - o **Global Surveillance and Communications**
 - o **Precision Strike**
 - o **Air Superiority and Defense**

HTMIAC BASIC INFORMATION PRODUCT

- **SUBSET OF DOD MILITARY MISSION/FUNCTION**
 - Detection and warning function is enhanced by laser-hardening components of detection systems
- **HTMIAC DATABASE ON LASER-INDUCED DAMAGE THRESHOLDS FOR SEMICONDUCTOR DETECTOR MATERIALS**
 - **What:** Create a database on laser-induced damage threshold (LIDT) data for semiconductor materials
 - **Who:** Mr. Peter D. Hughes at CALSPAN Corporation, White Sands, New Mexico
 - **Form:** Compiled literature data for LIDT of several semiconductor materials (Si, Ge, GaAs, InSb, HgCdTe, PbSnTe)

HTMIAC METHODOLOGY

- **METHODOLOGY EMPLOYED**
 - **Data Collection:** Comprehensive search of open literature for LIDT data on semiconductor detector materials (Si, Ge, GaAs, InSb, HgCdTe, PbSnTe)
 - **Data Analysis:** Search for factors that influence the LIDT
 - o Material characterization
 - o Laser beam parameters (wavelength, intensity/fluence, spot size, CW, RP, pulse duration)
 - o Detection and definition of LIDT
 - o Modeling of results
 - **Data Synthesis:** Compilation of analyzed LIDT data into database for dissemination
 - o Selection criteria derived from analysis results
 - o Basic unit of compiled data and technical information is "Data Set"
 - o Diskette copy was requested

HTMIAC METHODOLOGY (continued)

- **APPROACH FOLLOWED**
 - **Features of HTMIAC Database**
 - **Comprehensive compilation of analyzed data identified from extensive searches of open literature**
 - **Includes information on: material characterization, laser-beam parameters, LIDT definition and detection, modeling results (when available)**
 - **Data source references are included**
 - **Added Value: Creation of a single-source of analyzed data for LIDT of semiconductor materials**

SUMMARY OF DATA

● DATA COLLECTED

-- Data Search Results

- 72 sets of LIDT data for 7 semiconductors: Ge - 20, Si - 16, GaAs - 14, InSb - 5, HgCdTe - 9, PbSnTe - 4, Si PIN Diode - 4
- 27 distinct material types (material variables: dopants, stoichiometry, photovoltaic/photoconductor configuration)
- 25 data sources are referenced with publication dates from 1976 to 1988 (Boulder Damage Symposia, early LIDT work from Naval Research Laboratory, a recent review by Wood (1986))
- Laser wavelengths were mostly either 10.6 μ or 1.06 μ with a few other (5.0, 2.94, 2.76, 0.69, 0.248 μ)

-- Interesting Characteristics

- Extensive technical information for material characterization, laser-beam parameters, and LIDT definition was reported by several sources
- Pulsed laser beams (rather than continuous wave) were nearly always used
- Naval Research Laboratory (Bartoli et al.) was very active in development of models for pulsed laser damage thresholds

RESULTS OF DATA ANALYSIS

- **FINDINGS RESULTING FROM THE DATA ANALYSIS**

- The most complete sets of available data and information are for longer wavelengths. Extensions to shorter wavelengths are usually lacking
- Widespread differences exist in the way that damage is detected and defined (use of visible damage or electrical failure depends upon application)
- Development of predictive models for thermal damage requires extensive knowledge of material properties

- **SUMMARY OF TECHNICAL RECOMMENDATIONS**

- Considerable caution should be exercised when using damage threshold data due to the large number of factors involved

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS TECHNICAL INQUIRY?**

- The resulting database provides the data and information resource for semiconductor materials that was requested
- Financial Benefits to DoD
 - o The database is a single-source, data and information resource for LIDT of semiconductor materials
 - o Real cost savings are due to the ease and convenience of searching a personal computer diskette

RELEVANCE TO OTHER USERS

- **RELATED SUBSTANTIVE PROBLEMS FOR WHICH THE HTMIAC PRODUCT WOULD BE RELEVANT**
 - In broad terms, the database would be relevant to many activities in the Sensors or Materials and Processes DoD Key Technology Areas and in the Precision Strike S&T Thrust that deal with detector materials
- **ANALOGOUS PROBLEMS FOR WHICH THE HTMIAC PRODUCT WOULD BE RELEVANT BECAUSE OF THE DATA OR METHODOLOGY USED**
 - Methodology can be applied to creation of an electronic database for LIDT of other materials (i.e., optically transparent materials)

**STRATEGIC FORCES AND ARMS
CONTROL: INFRARED SIGNATURE
COMPUTER CODES**

Presented by:

**Rodney C. Anderson
Director**

**Infrared Information Analysis Center
Environmental Research Institute of Michigan**

Ann Arbor, MI 48113

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anderson@dmso.dtic.dla.mil

Approved for Public Release: Distribution Unlimited

CONTEXT

- Infrared threat systems are becoming more capable as focal plane science and signal processing capability advance. Signature modification is a robust counter to these advances.
- IRIA has a series of codes that may be used to assess the infrared signature of objects, propagation through the atmosphere, and detection performance
- Key technologies: Environmental effects, materials and processes, design automation
- Missions:
 - Strategic Forces (manned bombers)
 - Tactical Air Forces (land and sea based)
 - o Reconnaissance
 - o Deep strike
 - o Air superiority
 - Domestic Technology Transfer

IRIA SIGNATURE PREDICTION PRODUCTS

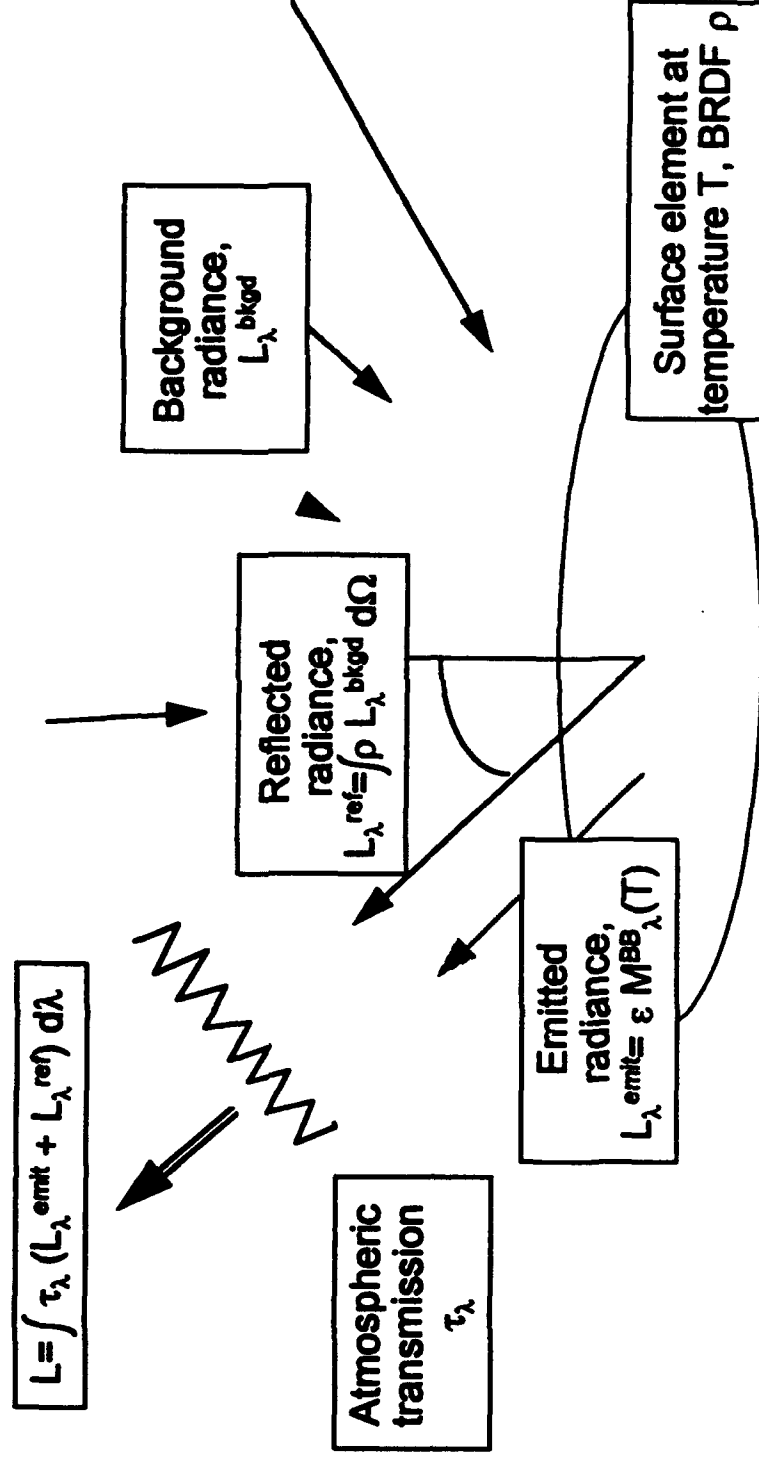
- **TARSIS infrared signature code**
 - computes source, apparent radiance contrast
 - sensor performance
- **APART atmospheric properties code**
 - Similar to LOWTRAN
 - fully correlated band computation
 - computes background radiance
- **CREEP**
 - ~~PRD~~
 - first principles coating reflectance predictions
 - unique capability
 - unclassified, but restricted distribution (preapproval required)

IAC METHODOLOGY

- **CODE DEVELOPMENT**
 - Third party development
 - Government owned (or rights)
 - Modifications and improvements by ERIM
- **DISTRIBUTION**
 - Source code, object code, test cases, and documentation included.
 - Codes available for variety of machines
 - o VAX
 - o UNIX workstation (SPARC, Indigo, IRIS)
 - o PC (some codes)
 - Source code not available for CREEP

CODE SUMMARY

- SIGNATURE PREDICTIONS
- TARSIS AND APART ADDRESS OVERALL VEHICLE AND ENVIRONMENT
- CREEP FOR COATING PREDICTIONS (BRDF)

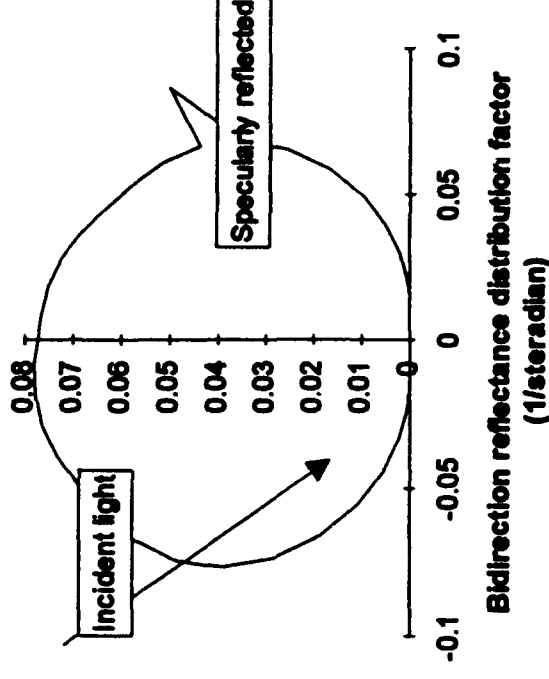


CREEP RESULTS

- **CREEP ARCHITECTURE**
 - Adding /doubling method used for radiative transport
 - Scattering
 - o Closed form Mie scattering
 - o Henyey-Greenstein
 - o Specified scattering phase function
 - Surface reflectance
 - o Specular (Fresnel)
 - o Computed
 - coherent/ incoherent domains
 - two scale lengths
- **CREEP VERIFICATION AND ASSESSMENT COMPLETED**
 - Code appropriate for comparison of coating designs
 - Supporting data required for absolute predictions

CONSEQUENCES

- **EXTENSIVE DISTRIBUTION**
 - Government
 - Industry
- **PROVIDES A CAPABILITY NOT PREVIOUSLY AVAILABLE**
 - Flexible first principles approach
 - Can be used in other spectral regimes
 - Wide application



TASK RELEVANCE

- **CREEP CODE RELEVANT TO:**
 - **Sensor performance**
 - **Mission analysis**
 - **Coating design**
 - **Dual use (product appearance)**
 - o **automotive**
 - o **other consumer industries**
- **CREEP METHODOLOGY RELEVANT TO:**
 - **Environmental assessment**
 - **Terrain typing**
 - **Atmospheric modeling (clouds and other optically thick media)**

ASSESSMENT OF ULTRA-WIDEBAND (UWB) RADAR TECHNOLOGY

Prepared by

**Vincent G. Puglielli, Ph.D.
Battelle Memorial Institute**

and

**Larry W. Williams, Ph.D.
Program Manager, TWSTIAC
Battelle Memorial Institute
505 King Avenue
Columbus, OH 43201-2693**

Approved for Public Release: Distribution Unlimited

[The final report for this study is Limited Distribution and/or Classified. AD B146 160]

CONTEXT

- **DoD S&T THRUSTS 1: GLOBAL SURVEILLANCE AND COMMUNICATIONS, 2: PRECISION STRIKE, AND 3: AIR SUPERIORITY AND DEFENSE**
- **DoD KEY TECHNOLOGIES: SENSORS/RADAR SENSOR TECHNOLOGY**
- **DoD MILITARY MISSIONS/FUNCTIONS: STRATEGIC FORCES, AIR DEFENSE**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-2

Puglielli.vu

TWSTIAC TASK/BASIC INFORMATION PRODUCT

TWSTIAC WAS ASKED TO:

- **EXAMINE THE STATE OF THE ART AND POTENTIAL BENEFITS OF UWB TECHNOLOGY, PARTICULARLY FOR RADAR APPLICATIONS**
- **IDENTIFY AND PRIORITIZE RESEARCH TO BE PURSUED**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-3

Puglielli.vu

TWSTIAC METHODOLOGY

- **BLUE RIBBON PANEL OF RESIDENT AND NATIONAL EXPERTS ON UWB TECHNOLOGY AND RADAR**
- **REVIEWED PRIOR UWB RADAR DEVELOPMENT**
 - **Experimental data**
 - **Literature--including Soviet**
- **REVIEWED ONGOING AND PROPOSED WORK**
 - **Government laboratories**
 - **Industry and academia**
- **DETERMINED POTENTIAL PERFORMANCE BENEFITS**
 - **Radar technologies, including against low-observable targets**
 - **Countermeasures, especially probability of detection**

Prepared by: V. G. Pugliesi-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-4

Pugliesi.vu

TWSTIAC METHODOLOGY (Continued)

- **IDENTIFIED TECHNOLOGY ISSUES/GAPS IN KNOWLEDGE/
PRIORITY OF IMPORTANCE**
- **RECOMMENDED NEEDED RESEARCH**
 - **Areas for further investigation**
 - **Experimental tools/hardware needed**
- **DETERMINED POSSIBLE APPLICATIONS**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-5

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ASSISTANCE DELIVERED

- **CONCENTRATED ON CHARACTERISTICS OF AND CLAIMS MADE FOR UWB TECHNOLOGY: RADAR, COMMUNICATIONS, ELECTRONIC WARFARE AND RF WEAPONIZATION**
 - No applications were advanced for communications
 - Government in-house committee was addressing applications to EW and RF weaponization
 - Therefore, this study concentrated on radar applications
- **FOCUSED ON CLAIMS FOR ULTRA-WIDEBAND "IMPULSE" RADAR AS BEING INHERENTLY:**
 - Counter-stealth (i.e., to defeat the F-117 and the B-2)
 - Low Probability of Intercept (LPI) (to defeat countermeasures)
 - Capable of detecting relocatable targets in camouflage/foliage
- **REVIEWED THE THEORETICAL BASES FOR CLAIMED CAPABILITIES**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-6

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RESULTS OF DATA ANALYSIS

- **IMPULSE RADAR IS NOT INHERENTLY COUNTER-STEALTH**
 - Conventional radars are able to exploit any vulnerabilities resulting from target shaping
 - No effects in RAM are unique to impulse radar
- **IMPULSE RADAR IS NOT INHERENTLY DIFFICULT TO DETECT**
 - It is difficult to make any radar hard to detect
 - Impulse radar has no special LPI characteristics, is readily detected by an appropriately designed intercept receiver
- **A PROPERLY DESIGNED IMPULSE RADAR MIGHT BE ABLE TO DETECT TARGETS SHIELDED BEHIND TREES (AS MIGHT ANY NON-IMPULSE UWB RADAR)**

Prepared by: V. G. Pugliese-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-7

Pugliese, VU

RESULTS (Continued)

- **ADVANCES IN SOURCES FOR VERY HIGH POWER SHORT PULSES MIGHT BENEFIT CONVENTIONAL SHORT PULSE RADAR AS WELL AS IMPULSE TRANSMITTERS**
- **CONVENTIONAL RADAR THEORY IS COMPLETELY ADEQUATE FOR UNDERSTANDING IMPULSE RADAR PHENOMENA--THERE IS NO UNIQUE THEORETICAL BASIS FOR UWB RADAR**
- **RECOMMENDATIONS WERE MADE:**
 - **Do analyses of point designs using both impulse and non-impulse radar approaches for four military applications**
 - **Do studies of clutter behavior of UWB radar systems and characteristics of UWB antennas**
 - **Do a modest study to document characteristics of self-induced transparency and other non-linear effects possibly relevant to military systems**

Prepared by: V. G. Pugliese-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-8

Pugliese, vu

CONCLUSIONS

- **INTERESTING WORK WAS UNDER WAY, AND SELECTED/LIMITED R&D INVESTMENTS COULD EXPLORE ITS POTENTIAL BENEFITS**
- **IMPULSE RADAR DOES NOT OFFER A MAJOR NEW MILITARY CAPABILITY, NOR DOES IT THREATEN A SERIOUS TECHNOLOGICAL SURPRISE**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-9

Puglielli.vu

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF THIS EFFORT?**

- **Financial benefits to DoD**

- Congress had mandated \$25M FY90 funds be spent on this technology. This effort helped to focus investment of \$10M FY90-91 and \$12M FY92-93 funding for UWB into theoretically sound, technologically promising, and operationally appropriate R&D
- Avoided "Loss Leader" construction of an unnecessary UWB radar site-- future investments could have been multiples of \$25M

- **Other benefits to DoD**

- Disproved unfounded challenges against the viability of stealth technologies
- Discredited claims that the U.S. was at risk of major technological surprise
- Brought some discipline and technical foundation to a highly visible, poorly described technology as an aid to decision makers
- Laid the foundation for subsequent technology developments which are significant for several applications, the most notable proving to be foliage penetration radar.

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-10

Puglielli.vu

RELEVANCE TO OTHER USERS

- **THE METHODOLOGY OF A "BLUE RIBBON" TEAM OF HIGH QUALITY/INTEGRITY UNDER IMPARTIAL ORGANIZATIONAL LEADERSHIP CAN BE APPLIED TO ANY PROBLEM WHERE TECHNICAL CONFUSION IS WIDESPREAD AND UNUSUAL CLAIMS MAY BE THE BASIS FOR DoD INVESTMENT**
- **THE REPORT STANDS AS A SOUND GUIDE FOR FUTURE PLANNERS IN THIS TECHNOLOGY. THE BASIC PHYSICS WHICH FORMS THE REPORT'S FOUNDATION WILL NOT CHANGE WITH TIME. THE TECHNOLOGY CONTINUES TO ADVANCE ALONG THE LINES PREDICTED.**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-11

Puglielli.vu

TACTICAL AIR FORCES

INTERACTIVE DECISION TRAINING SCENARIO FOR USN DAMAGE CONTROL AND CBR-D DECISION TRAINING

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **SEA CONTROL AND TACTICAL NAVAL SURFACE FORCES**
 - **Naval Interdictions**
 - **Operate in Littoral Zones**
 - **Losses to a Minimum**
- **NBC ENVIRONMENT LIKELY**
 - **Proliferation**
 - **Increased use Scenarios**

IAC TASK

- **WHAT**
 - **Interactive Damage Control Scenario Presentation System (DECAID)**
- **WHY**
 - **Risk Management Essential in CBR Environments**
 - **Increased Burdens**
 - **Competing Demands**
 - **Training Shortfall -- Integration of CBR Defense with other Damage Control Functions**
- **WHO**
 - **U.S. Naval Training Systems Center**

IAC METHODOLOGY

- **DEVELOP DAMAGE CONTROL DECISION TASKS AND RISK MANAGEMENT DILEMMAS**
- **DEVELOP DECAID SCENARIOS**
 - **Fire**
 - **Flood**
 - **Chemical Attack**
 - **Combinations**
- **DEVELOP DECAID RULE BASE USING INPUT FROM SUBJECT MATTER EXPERTS (SMES)**
- **DEVELOP INTERACTIVE DEMONSTRATION**
- **REVIEW BY NAVY USERS**

SUMMARY OF DATA

- **DEVELOPED**
 - **Scenarios**
 - **Interface Features**
 - **Controls, Displays, etc**
 - **Rules**
 - **Firemen, crew, event**
 - **Software (Primarily in C)**
- **CONDUCTED DEMONSTRATIONS**

RESULTS

- **SUCCESSFUL "6.2" DEMONSTRATION OF CONCEPT**
 - **Instructors of Navy Advance CBR Course**
 - **Surface Warfare Officer School**

CONSEQUENCE

- **PRODUCT INTEGRATED INTO NAVY TRAINING COURSE**
- **USN PURSUING ADDITIONAL DEVELOPMENT**

SMART WEAPONS OPERABILITY ENHANCEMENT (SWOE) PROGRAM

Presented by

**Peter D. Smallidge
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Program Manager

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **DOD SCIENCE AND TECHNOLOGY THRUST**
 - Synthetic Environments: Provide computer- and electronics-based technology for development, testing, training and readiness to synthesize factory-to-battlefield environments.
 - Precision Strike: Against critical mobile and fixed targets in all-weather; day/night; and foliage- and camouflage-resistant environments.
- **DOD KEY TECHNOLOGY**
 - Environmental Effects: The automated generation of near-real-time environmental tactical decision aids to determine the adverse effects of dynamic battlefield environments on characterization and modeling of military requirement and operations.
- **DOD CRITICAL TECHNOLOGY**
 - Simulation and Modeling
 - Weapon System Environment

IAC TASK / BASIC INFORMATION PRODUCT

- **ARMY TECHNOLOGY BASE MASTER PLAN**

- Science and Technology Objective, VI.C.5., Smart Weapons Operability Enhancement
 - » Develop analytical IR and MMW models to robustly simulate geographical and time/weather driven character of environmental scenes.
 - » Develop validated multi-sensor scene generation capability for quantitative consideration of environmental conditions in the design, test and evaluation of smart weapon and ATR devices.

- **IAC PRODUCT FOCUS**

- Survey and analyze environmental science technologies to support development of an integrated, physics based, scene generation process.
 - » Measurement and Information Bases
 - » Analytical Models
 - » Scene Rendering Software
- Customer:
 - » OSD Joint Test & Evaluation Program
 - » U.S. Army Smart Weapons Management Office
 - » Individual Emerging Systems

SELECTED PRODUCTS

SWOE PROGRAM

- 88-1, Program Implementation Plan, USACRREL, Jan 89
- 90-1, One-Dimensional Temperature Modeling Techniques, EG&G Energy Measurements / SPARTA / NASA Goddard Space Flight Center, Aug 90
- 90-8, Representative Weather Data Sets for Hunfeld, Federal Republic of Germany, USAASL, Jul 90
- 90-9, Comparison of Climatologies of Selected SWOE Test Sites, USAASL, Aug 90
- 90-15, Three Dimensional Modelling of Background Scenes at Millimeter Waves, MIT Research Lab. of Electronics, Dec 90
- 92-1, Information Base Procedures for Generation of Synthetic Thermal Scenes, USAEWES, Feb 92
- 92-2, Review of Environmental Research Specific to SWOE for the Battlefield Environment, USACRREL/USATEC/ USAEWES, Jun 92
- 92-6, Data Analysis for Bark and Leaf Reflectance Measurements, Spectral Sciences, Inc./Phillips Lab., Jun 92
- 93-1, A Review of Millimeter Wave Modeling, USACRREL, Mar 93

IAC METHODOLOGY

- **DATA BASES**
 - Survey environmental data from military test sites
 - Analyze for
 - » Validity
 - » Range of relevant conditions
- **MODELS**
 - Initial survey of sensor models relevant to smart weapons - IR and MMW
 - Survey and compilation of IR models
 - Workshop to establish / synthesize MMW techniques
- **SIMULATION**
 - Survey government and commercial technologies
 - Evaluate based on smart weapon system drivers / parameters

SUMMARY OF FINDINGS

- **PERFORMANCE OF SMART WEAPONS SYSTEMS HAS BEEN UNPREDICTABLE AND UNRELIABLE FOR EXTRAPOLATION TO THE GLOBAL RANGE OF BATTLEFIELD CONDITIONS.**

- Effects of the environment are treated in generic rather than specific ways.
- There are no environmental criteria for development or testing. The environment is not defined in terms relevant to the performance of smart weapons.
- Environment performance criteria are not keyed to the specific regions within which that system must operate.

- **OPTIONS TO SOLVE THE PROBLEM**

- Real imagery data
- Hybrid imagery
- Synthetic imagery

CONSEQUENCES

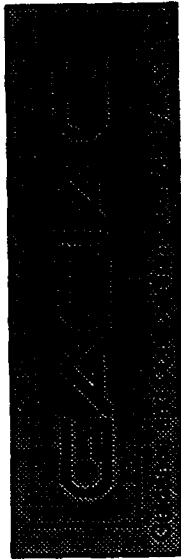
- **RECOMMENDED APPROACH:**
 - Validated scene generation process
 - » Integrated physics based models
 - » Terrain and weather data base driver
 - » Workstation environment
 - Compatibility with Distributed Interactive Simulation
- **RESULT:**
 - Smart Weapon Operability Enhancement Joint Test & Evaluation (SWOE JT&E) program initiated in 1992, \$15.2M funding, 3 years
 - Impact: Early consideration of environment in design, optimization of testing, extrapolation of test results

RELEVANCE TO OTHER USERS

- **PHYSICAL SECURITY SYSTEMS**
 - Sensor performance design and evaluation
 - Criteria for logic design to reduce false alarms
- **REMOTE SENSING**
 - Mission planning
 - Image analysis criteria
 - New sensor design / evaluation

Prepared by: P. D. Smallidge

IAC SWOE -7



PRECISION STRIKE

PREPARED BY

JOSEPH J. PETROVIC

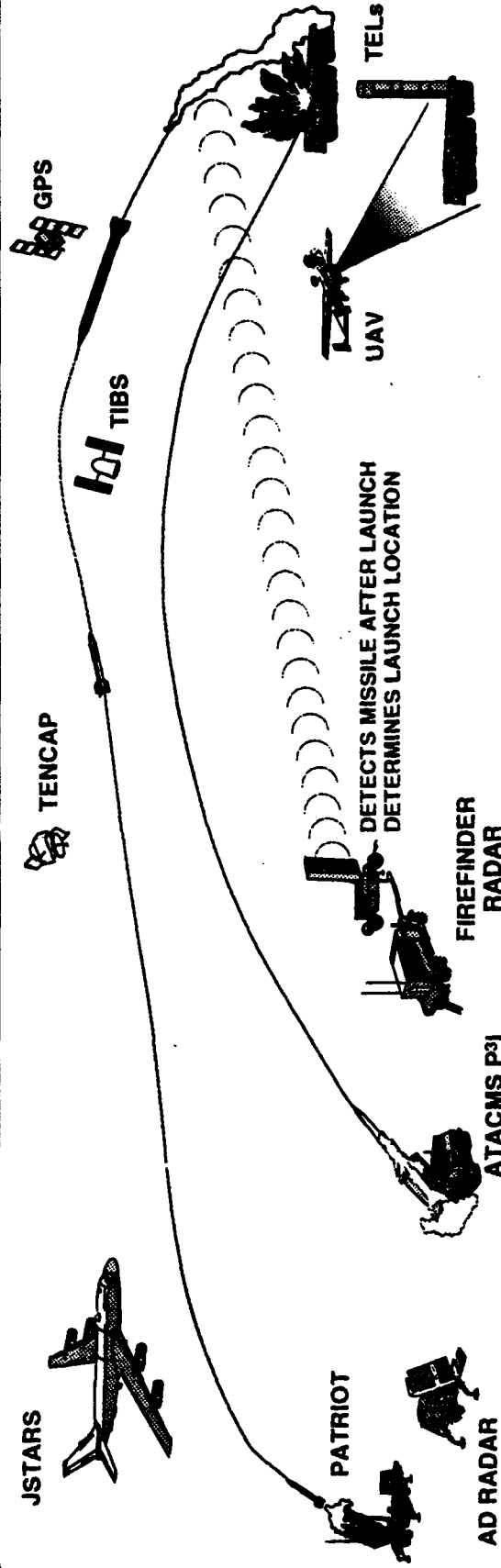
GUIDANCE AND CONTROL INFORMATION ANALYSIS CENTER

IIT RESEARCH INSTITUTE

10 WEST 35 STREET

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PRECISION STRIKE CONTEXT



DEFINITION

- LOCATE HIGH VALUE, TIME-SENSITIVE FIXED AND MOBILE TARGETS (SCUDs/TBMs)
 - DESTROY THEM WITH A HIGH DEGREE OF CONFIDENCE
 - WITHIN A TACTICALLY USEFUL TIMELINE
 - EFFECTIVE PRECISION STRIKE CAPABILITY
- REDUCES CASUALTIES
PROVIDES ECONOMY OF FORCE
REDUCES DEMAND FOR WEAPON PLATFORMS

Presented By: **GACIAC**
J. J. PETROVIC

REQUIREMENTS

- TARGET ACQUISITION - DETECTS MISSILE BEFORE OR SHORTLY AFTER LAUNCH USING TENCAP, ENHANCED FIREFINDER, JSTARS, UAV ENDURANCE
- USES C3I NETWORK TO COUNTER / INTERCEPT INCOMING BALLISTIC MISSILES
- USE COUNTERFIRE / IEW ASSETS TO TRACK / ENGAGE TBM LAUNCHER
 - ENHANCED FIREFINDER (EnFF)
 - TACTICAL INFORMATION BROADCAST SYSTEM (TIBS)
- CONFIRM TARGETS STATUS WITH BATTLE DAMAGE ASSESSMENT (BDA)

PRECISION STRIKE BATTLE LABS/LOUISIANA MANEUVERS IAC TASK

- **SUPPORTED TECHNOLOGY DEMONSTRATIONS OF SIX MISSILE SHOTS AT WHITE SANDS MISSILE RANGE (WSMR)**
- **EVALUATED ENHANCED FIREFINDER (TPQ-37 RADAR) ABILITY TO DETECT A TACTICAL BALLISTIC MISSILE (TBM) AT EXTENDED RANGES**
- **CONDUCTED A C³I TIME-LINE ANALYSIS OF THE DETECTION, TRACKING, AND COUNTERFIRE MISSILE EVENTS WITH THE D&SA BATTLE LAB AT FT. SILL**
- **SIMULATED THE USE OF JSTARS, UAV, FDDM, MLRS LAUNCHER FOR ATACMS WHILE ACTUALLY USING A TPQ-37 RADAR TRACKING A LAUNCH AT WSMR AND A TACFIRE AT FT. SILL, OK**
- **LATER LAUNCHES DETECTED AND TRACKED MISSILE WITH TPQ-37 RADAR AND HANDED OFF TRACK TO AN AIR DEFENSE NODE**
- **LOUISIANA MANEUVERS - CDRs / STAFF CAN USE REALISTIC C³I TIMELINES TO GAME / SIMULATE RESPONSE ALTERNATIVES**

GACIAC SPECIAL TASKS PROVIDED SUPPORT FOR CRITICAL TECH DEMO THROUGH TRADOC BATTLE LABS / LOUISIANA MANEUVERS

PRECISION STRIKE TRADOC BATTLE LABS

MOUNTED BATTLESPACE
FT. KNOX, KY

BATTLE COMMAND
FT. LEAVENWORTH, KS

DEPTH AND SIMULTANEOUS ATTACK
FT. SILL, OK

COMBAT SERVICE SUPPORT
FT. LEE, VA

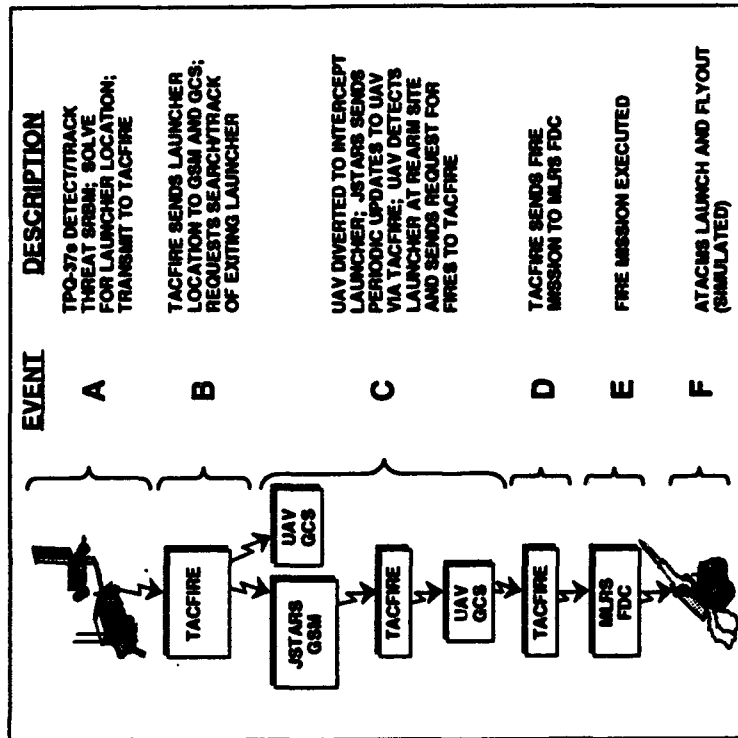
EARLY ENTRY, LETHALITY
AND SURVIVABILITY
FT. MONROE, VA

DISMOUNTED BATTLESPACE
FT. BENNING, GA

- EXPLOIT DISTRIBUTED INTERACTIVE SIMULATION REVOLUTION
- BRING USER, LAB, AND INDUSTRY TOGETHER TO EVALUATE VIRTUAL PROTOTYPES, TECH DEMOS IN FIELD ENVIRONMENT, AND "HOW TO FIGHT" CONCEPTS
- HORIZONTAL INTEGRATION OF TECHNOLOGY FOR SYSTEM UPGRADES

Presented By: **GACIAC**
J.J. PETROVIC

PRECISION STRIKE TEST AND EVALUATION

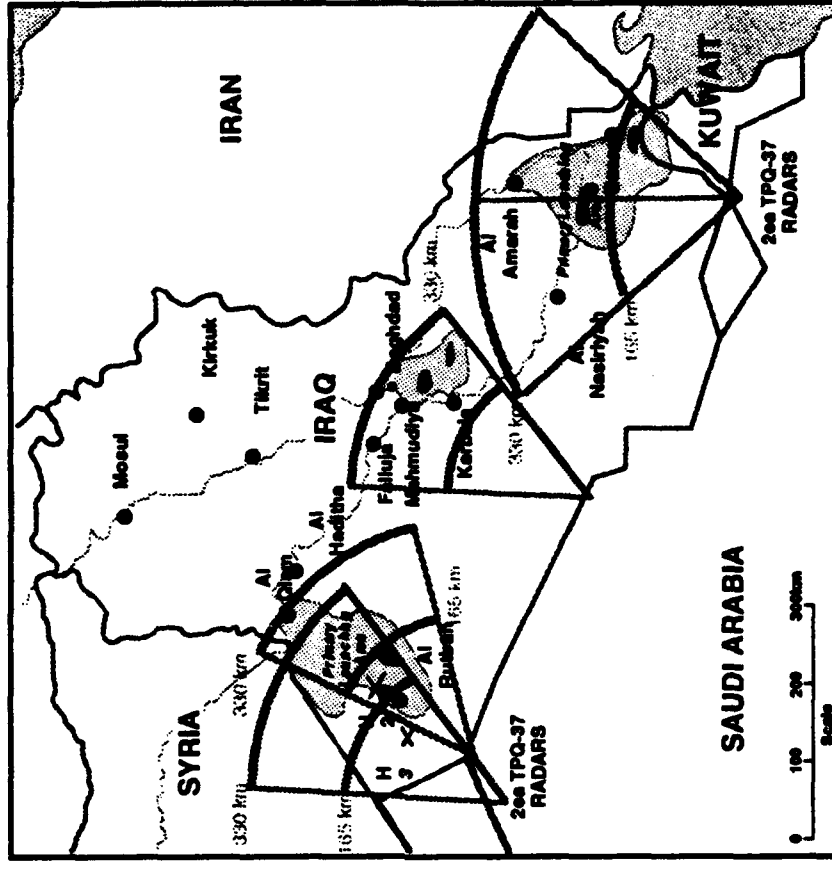


IACS ASSIST USERS IN EVALUATING PRECISION STRIKE
THROUGH REAL-TIME TEST AND EVALUATION

Presented By: **GACIAC**
J. J. PETROVIC

PRECISION STRIKE STUDIES & ANALYSIS

- CONDUCTED AN ASSESSMENT OF SCUD FIRINGS AGAINST ISRAEL AND SAUDI ARABIA DURING DESERT STORM
- EXAMINED THREAT TACTICAL BALLISTIC MISSILES (TBM) IN SWA (IRAQ) AND NEA (N. KOREA)
- PROJECTED ENHANCED FIREFINDER PERFORMANCE AGAINST TBM CONSIDERING RCS, TRAJECTORY, AND RANGE
- DETERMINED THE REQUIRED PERFORMANCE FOR THE BLOCK II FIREFINDER IMPROVEMENTS AND THE NUMBER OF SYSTEMS NEEDED TO PROVIDE COUNTRYWIDE COVERAGE



IACS CAN PROVIDE PMs / PEOs / RDECs WITH INDEPENDENT
ANALYTICAL SUPPORT FOR SYSTEM P3I AND DoD S&T THRUST AREA

Presented By: **GACIAC**
J. J. PETROVIC

PRECISION STRIKE COMMAND, CONTROL, COMMUNICATIONS, AND INTELLIGENCE

- DESERT STORM REVEALED WEAKNESSES IN U.S. ABILITY TO RESPOND TO SCUD / TBM THREAT
- STUDY REQUIRED TO APPRECIATE THE INTELLIGENCE INDICATORS AND SPECIFIC EVENTS
- DETECTION REQUIRES DEDICATION OF SELECTED TARGET ACQUISITION / IEW ASSETS AND NETTING OF SENSORS
- COUNTERING MISSILE REQUIRES EFFICIENT / TIMELY HANDOFF TO AIR DEFENSE SYSTEMS
- COUNTERING LAUNCHING / SUPPORT VEHICLES REQUIRES CAREFUL INTEGRATION / HANDOFF OF NATIONAL / SERVICE SENSOR DATA TO EXECUTE AN EFFECTIVE COUNTERFIRE MISSION
- IDEALLY, IDENTIFY ASSETS / LOCATION AND DESTROY PRE-EMPTIVELY
- IDENTIFY LAUNCH SITE ACCURATELY
- TRACK ACTIVITY AT LAUNCH SITE AND MOVEMENT TO HIDE
- DIVERT SENSORS TRACK / PROVIDE BATTLE DAMAGE ASSESSMENT (BDA)
- DIVERT ASSETS TO ENGAGE TARGET OR PROVIDE COUNTERFIRE MISSION TO DEDICATED ASSETS
- CONDUCT BDA TO KNOW REAL RESULTS

TIMELY C³I ESSENTIAL FOR EFFECTIVE PRECISION STRIKE



SERVICE LIFE EXTENSION ASSESSMENT

(DoD MISSION/FUNCTION: TACTICAL NAVAL SURFACE FORCES)

Prepared By

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Approved for Public Release: Distribution Unlimited

CAPABILITY RELEVANCE

- **DOD MISSION/FUNCTION: TACTICAL NAVAL SURFACE FORCES**
- **CAPABILITY RELEVANCE**
 - **Service life extension assessment for variety of applications**
 - o DoD budget costs
 - o Longer nonoperational periods
 - o Unknown failure mechanisms
- **CAPABILITY IMPACT**
 - **Reductions in life cycle costs and improved readiness**

NEEDED LIFE EXTENSION ASSESSMENT GUIDANCE

- **CONSISTENT METHODOLOGY**
 - **Definition of alternatives**
 - **Flow of steps**
 - **Decision criteria**
- **IDENTIFICATION OF DATA NEEDS/DATA RESOURCES**
- **DOCUMENTATION OF APPLICATION CASE HISTORIES**
- **ANCILLARY ISSUES**
 - **Politics**
 - **Environmental Requirements**
 -
 -
 -
- **RAC PUBLICATION "SERVICE LIFE EXTENSION ASSESSMENT"**

POTENTIAL AREAS FOR WEAROUT MECHANISM INVESTIGATION

(LIFE-LIMITED PARTS, MATERIALS, AND COMPONENTS)

**Materials Subject To
Breakdown Over Time**

- Insulation
- Rubber
- Adhesives
- Metals (Corrosion)

Moving Parts

- Bearings
- Pumps
- Actuators

Parts with Electrical Contacts

- Switches
- Relays
- Connectors

Seals

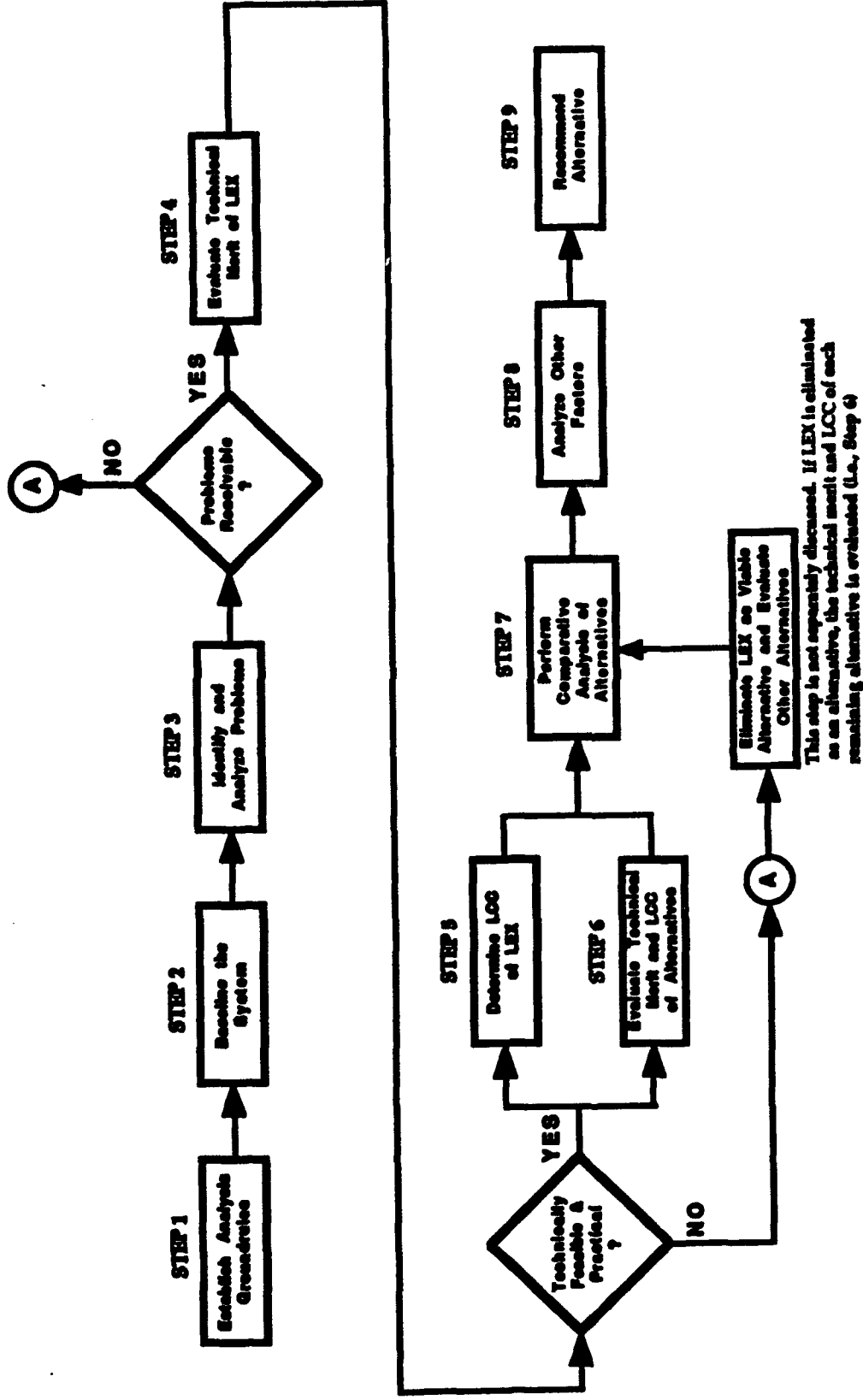
**Components with
Chemical Reactions**

- Batteries
- Propellants
- Some capacitors

Protective Coatings

- Paint
- Anodizing
- Plating





Flow Chart of a Generalized Life Extension Assessment Process

CAPABILITY APPLICATIONS

- **MISSILE SYSTEMS**
- **UTILITY INDUSTRY**
- **HEAVY EQUIPMENT**
 -
 -
 -
- **ANY CAPITAL INTENSIVE ACQUISITION WHERE EXISTING
HARDWARE AT OR NEAR END OF LIFE**

RAC ROLE:

- **Publisher of guidance book**
- **Applier of assessment approach**

**U.S. AIR FORCE SURFACE-TO-AIR
ENGAGEMENTS DURING OPERATION DESERT STORM**

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- SUPPORT TACTICAL LAND- AND SEA-BASED AIR FORCES
SURVIVABILITY DESIGNS ENHANCING AIR SUPERIORITY BY:
 - Collecting and Preserving Data on Surface-To-Air Threat
Weapon System Encounters that Occurred During
Operation Desert Storm

U.S. AIR FORCE SURFACE-TO-AIR ENGAGEMENTS DURING OPERATION DESERT STORM

- **DOD S & T THRUST**
 - **Air Superiority**
- **SURVIAC TASK FOCUS**
 - **Collect and Analyze Data on Surface-To-Air Engagements from Operation Desert Storm**
 - **Preserve and Provide Data to be Used for Research by Military Services and Scientific Community**

SURVIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Data Collected Under the COARP (Combat Operations Assessment and Reporting Program)**
 - **Data Reported in "Red Baron" Type Format**
 - **Data Stored in a DoD Classified Database**
- **APPROACH**
 - **Rapidly Instituted COARP Data Collection Approach to Respond to Desert Storm**
 - **Applied Technique Used in Southeast Asia Battle Damage Assessment and Reporting Program (BDARP)**
 - **Developed Standardized Source Document for Data Collection**
 - **Trained Teams to Conduct On-Site Data Collection Interviews**

SUMMARY OF DATA

- **DATA COLLECTED**

- **Combat Incident Data on All USAF Surface-To-Air Threat Encounters During Desert Storm**
- **Operations Information**
- **Damage and Effects Data**
- **Maintenance Records**

RESULTS OF DATA ANALYSIS

- **FINDINGS SYNTHESIZED BY SURVIAC**
 - **COARP Proved to be a Successful Combat Data Preservation Effort**
 - **Complied with Deputy Secretary of Defense Memo, 31 Jan 91 and AF Office of Assistant Secretary Memo, 5 Feb 91 to Preserve Combat Operations Data**
 - **Combat Data Critical to Improving the Capability of Fielded Systems**
 - **Data Preservation Vital to Design of Next Generation Systems that Are More Survivable and More Effective**
- **SUMMARY OF TECHNICAL RECOMMENDATIONS**
 - **Institute a Program that Includes a Stand-By Capability to Collect Combat Data When Conflicts Occur**

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS SURVIAC PRODUCT**
 - **Financial Benefits to DoD**
 - **Potential to Decrease Aircraft Wartime Attrition Through Application of Lessons Learned**
 - **Other Benefits to DoD**
 - **Improvement in Combat Effectiveness, Readiness, and Reduction of Casualties**
 - **Changes in DoD Operations, Plans, or Procedures as a Direct Result of Product**
 - **Wartime Tactics Changed in Response to Combat Operations Lessons Learned**

RELEVANCE TO OTHER USERS

- **DATA COLLECTION APPROACH AND METHODOLOGY APPLICABLE TO OTHER APPLICATIONS WHERE A QUICK REACTION CAPABILITY IS REQUIRED**
- **NO DIRECT APPLICABILITY OF THE CURRENT COMBAT DATA OUTSIDE THE DOD**

ANALYSIS OF EFFECTS OF NEW WEAPONS SYSTEMS IN THE EMPLOYMENT OF TACTICAL AIR FORCES

Prepared by

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Battelle Memorial Institute**

and

**Larry W. Williams, Ph.D.
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[The final report for this study is Limited Distribution and/or Classified.]

CONTEXT

- PROVIDED C3I SYSTEMS ANALYSIS, MODELING AND SIMULATION CAPABILITY AT ESC/SRPM (MASC) IN SUPPORT OF S&T THRUST 3: AIR SUPERIORITY AND DEFENSE
- DOD FORCE, ROLE, MISSION OR FUNCTION
 - Tactical Air Forces
 - Command Control and Communications
 - Ground Forces

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-2

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TWSTIAC TASK/BASIC IAC INFORMATION PRODUCT

- **SUBSET OF KEY TECHNOLOGY, S&T THRUST, DOD FORCE, MISSION, ROLE OR FUNCTION OBJECTIVE TO BE ADDRESSED**

- **Tactical air forces--C3I**

• TWSTIAC TASK/INFORMATION PRODUCT FOCUS

- **Develop, update and validate**
 - **Realistic scenarios**
 - **Databases**

**Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC**

TWSTIAC-3

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TWSTIAC TASK/BASIC IAC INFORMATION PRODUCT

(Continued)

- Support investigating the effects and effectiveness of changes to
 - Planned weapon systems
 - Modifications to existing weapon systems
- Rigorous analysis of air combat capability

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

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TWSTIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Conducted seminars on**
 - **Doctrine**
 - **Tactics**
 - **Planning (force and unit level)**
 - **Concept of operations/employment**
 - **Develop checklist for MASC staff use**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

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TWSTIAC APPROACH

- **DEVELOPED SCENARIOS COMPATIBLE WITH MODELS**
 - **EADSIM**
 - **Suppressor**
 - **BRAWLER**
 - **Mitre ADSIM**
- **MEMBER OF CORE TEAM**
 - **Mix of Air Force Mitre and support contractors**
 - **Retains corporate memory**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-6

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TWSTIAC APPROACH

(Continued)

- **DATA COLLECTION**
 - **Battelle-held data**
 - **SPOES**
 - **Operational units and headquarters**
- **WORK IN SECURE AIR FORCE FACILITY (HANSCOM AFB)**
- **INFORMATION HOLDINGS AND STAFF EXPERTISE**
- **DATA ON WEAPON SYSTEMS**
- **Scenarios**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

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SUMMARY OF DATA

- **DATA COLLECTED**
 - **Blue weapons systems**
 - **Red weapons systems**
 - **Doctrine/tactics for both**
 - **Adapt to different models for realistic simulation**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

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RESULTS OF DATA ANALYSIS

- **FINDINGS RESULTING FROM ANALYSIS OF DATA COLLECTED BY TWSTIAC**

- **Realistic scenarios and data used to analyze**
 - **AWACS improvements**
 - **Joint Stars self defense**
 - **JINTACS usefulness**
 - **TMD operations**

- **SUMMARY OF TECHNICAL RECOMMENDATIONS**

- **Add equipment to AWACS**
- **Add equipment to Joint Stars**
- **JINTACS will improve combat effectiveness of fighters**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

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CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS IAC PRODUCT?**
 - **Supported decisions to improve the AWACS**
 - **Higher kill rates by Blue fighters**
 - **Supported decisions to improve the Joint Stars**
 - **Better information to land commanders**
 - **Lower Blue casualties**
- **METHODOLOGY HAS BEEN PERPETUATED BY THE AIR FORCE TO SUPPORT COMMAND AND CONTROL DEVELOPMENTS**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

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RELEVANCE TO OTHER USERS

- **OTHER SERVICES COULD EMPLOY THE METHODOLOGY TO GUIDE MODELING, SIMULATION, DEVELOPMENTS FOR COMMAND AND CONTROL**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-11

Wallace.vu

NAVAL FORCES

SHIP SUPERSTRUCTURE ICING

Presented by

**Peter D. Smallidge
CECRL-ORTA**

Authored by

**Dr. Charles C. Ryerson, CECRL-RS, and LCDR Paul D. Longo, USN
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CONTEXT

- **DOD KEY TECHNOLOGY**
 - Environmental Effects: The automated generation of near-real-time environmental tactical decision aids to determine the adverse effects of dynamic battlefield environments on characterization and modeling of military requirement and operations.
- **DOD SCIENCE AND TECHNOLOGY THRUST**
 - Sea control and undersea superiority. The need to maintain an overseas presence and operate in littoral zones in a broad range of environmental conditions.
- **DOD CRITICAL TECHNOLOGY**
 - Simulation and Modeling

IAC TASK / BASIC INFORMATION PRODUCT

- **RESEARCH OBJECTIVE:**

- Allow vessels to avoid hazardous conditions or to minimize the accretion of ice by predicting:
 - » Environmental conditions under which icing may occur
 - » Icing rates
 - » Predominant icing locations on the vessel

- **IAC PRODUCT FOCUS**

- Survey and analyze existing ship spray icing models
- Evaluate available data on ship icing
- Customer: U.S. Navy David W. Taylor Naval Ship Research Center

SUMMARY OF DATA

- **MODELS**
 - Most are empirical and based on trawler data
 - Do not consider the physical processes they simulate
 - Cannot be transferred to larger ships
 - University of Alberta numerical ship icing model
- **DATA**
 - Lack of data on large ship icing

CONSEQUENCES

- **RESEARCH EFFORTS**
 - Calibration and validation of Alberta model
 - Development and evaluation of spray and ice measurement equipment
 - Research cruise USCGC Midget
- **RESULTS**
 - Good video and weather data
 - Partial success on automated spray and icing measurements
 - Sufficient data to verify Alberta model for Navy

RELEVANCE TO OTHER USERS

- **OTHER DIRECT APPLICATIONS**
 - **Shoreline / coastal facilities**
 - » **Logistics over the shore**
 - » **Coastal radar / communications facilities**
 - » **Offshore oil platforms**
 - **Commercial fishing and shipping**
- **SPINOFFS**
 - **Shipboard instrumentation lessons learned**

Prepared by: P. D. Smallidge

IAC-ICE-5

**FAILURE ANALYSIS ON ELECTROSLAG REMELT
(ESR) 4340 STEEL**

Prepared by

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West Lafayette, IN 47906-1398**

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CONTEXT

- **BROAD OBJECTIVE OF DOD S&T THRUST AREA ON ADVANCED LAND COMBAT**
 - The ability to rapidly deploy our ground forces to a region, exercise a high degree of tactical mobility, and overwhelm the enemy quickly and with minimal casualties in the presence of a heavy armored threat and smart weaponry requires highly capable land combat systems
- **BROAD OBJECTIVE OF DOD KEY TECHNOLOGY AREA ON MATERIALS AND PROCESSES**
 - The DoD Materials and Processes technology area spans the spectrum of structural, thermal protection, non-structural, and electronic materials. Cost-effective, integrated manufacturing technology is implicitly included in each of the above materials areas
- **DOD MILITARY MISSION/FUNCTION**
 - Ground Forces
 - Domestic Technology Transfer

MIAC FOCUSED BIBLIOGRAPHIC SEARCH

- **SUBSET OF DOD MILITARY MISSION/FUNCTION**
 - **Close Air Support**
 - o **Mixer Pivot Support for the AH-64 Apache Helicopter**
- **FOCUS: BIBLIOGRAPHIC SEARCH FOR PROPERTY DATA ON
SPECIFIC MATERIALS**
 - **What: Provide Information on Failure of Electroslag Remelt
(ESR) 4340 Steel**
 - **Who: Army Research Laboratory Materials Directorate,
Watertown, Massachusetts**
 - **Form: Compilation of Evaluated Pertinent Information from
Published Literature**

MIAC METHODOLOGY

- **METHODOLOGY EMPLOYED**

- Computer search of all available information on failure of ESR 4340 was conducted
- Information sources were gathered and analyzed for content and usefulness
- All pertinent information was organized, packaged and delivered

- **SPECIAL PROVISIONS**

- Literature collection was to encompass all information readily available to MIAC
- Results needed to be prepared for delivery within 6 hours

SUMMARY OF DATA

- **LITERATURE INFORMATION COLLECTED**
 - **Over 300 pages of relevant information was analyzed and prepared for overnight delivery within six hours of the inquiry request**
- **Characteristics**
 - **Failure was analyzed as a function of stress, temperature, environment and processing**

RESULTS

- **FINDINGS RESULTING FROM ANALYSIS**
 - **Failure mode of ESR 4340 steel under various conditions**
- **TECHNICAL RECOMMENDATIONS**
 - **Using the information provided by MIAC, Army Research Laboratory Materials Directorate made recommendations on the inspection interval and method as well as material processing to ensure the safe operation of the AH-64 Apache helicopter**

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS MIAC INQUIRY?**
 - **MIAC's ability to complete task on short notice enabled the Army to quickly analyze and address the problems being faced by the Apache helicopter in Operation Desert Storm**
 - **Financial Benefits to DoD**
 - o **Saved Time - MIAC was able to secure all the background information in less than 24 hours**
 - o **Saved money by their not having to search and acquire all documents of possible interest**
 - o **Savings from having a better search done by skilled information specialist**
 - **Other Benefits to DoD**
 - o **Apache helicopter will have less down time for repair**
 - o **Apache helicopter will be safer to fly**
 - o **Other applications of ESR 4340 could benefit from the material provided**

RELEVANCE TO OTHER USERS

- **RELATED SUBSTANTIVE PROBLEMS FOR WHICH MIAC PRODUCT WOULD BE RELEVANT**
 - This and other information generated by similar technique would be of interest to anyone who designs, builds, tests, or specifies military hardware
 - Information would also be of interest to designers of automobiles and other equipment that uses ESR 4340
- **ANALOGOUS PROBLEMS FOR WHICH MIAC PRODUCT WOULD BE RELEVANT BECAUSE OF THE METHODOLOGY USED**
 - Methodology used in this work for the collection and analysis of materials' bibliographic information can be used for any materials and properties

SERVICE LIFE EXTENSION ASSESSMENT

(DoD MISSION/FUNCTION: TACTICAL NAVAL SURFACE FORCES)

Prepared By

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Approved for Public Release: Distribution Unlimited

CAPABILITY RELEVANCE

- **DOD MISSION/FUNCTION: TACTICAL NAVAL SURFACE FORCES**
- **CAPABILITY RELEVANCE**
 - **Service life extension assessment for variety of applications**
 - **DoD budget costs**
 - **Longer nonoperational periods**
 - **Unknown failure mechanisms**
- **CAPABILITY IMPACT**
 - **Reductions in life cycle costs and improved readiness**

NEEDED LIFE EXTENSION ASSESSMENT GUIDANCE

- **CONSISTENT METHODOLOGY**
 - **Definition of alternatives**
 - **Flow of steps**
 - **Decision criteria**
- **IDENTIFICATION OF DATA NEEDS/DATA RESOURCES**
- **DOCUMENTATION OF APPLICATION CASE HISTORIES**
- **ANCILLARY ISSUES**
 - **Politics**
 - **Environmental Requirements**
 -
 -
 -
- **RAC PUBLICATION "SERVICE LIFE EXTENSION ASSESSMENT"**

POTENTIAL AREAS FOR WEAROUT MECHANISM INVESTIGATION

(LIFE-LIMITED PARTS, MATERIALS, AND COMPONENTS)

**Materials Subject To
Breakdown Over Time**

- Insulation
- Rubber
- Adhesives
- Metals (Corrosion)

Moving Parts

- Bearings
- Pumps
- Actuators

Parts with Electrical Contacts

- Switches
- Relays
- Connectors

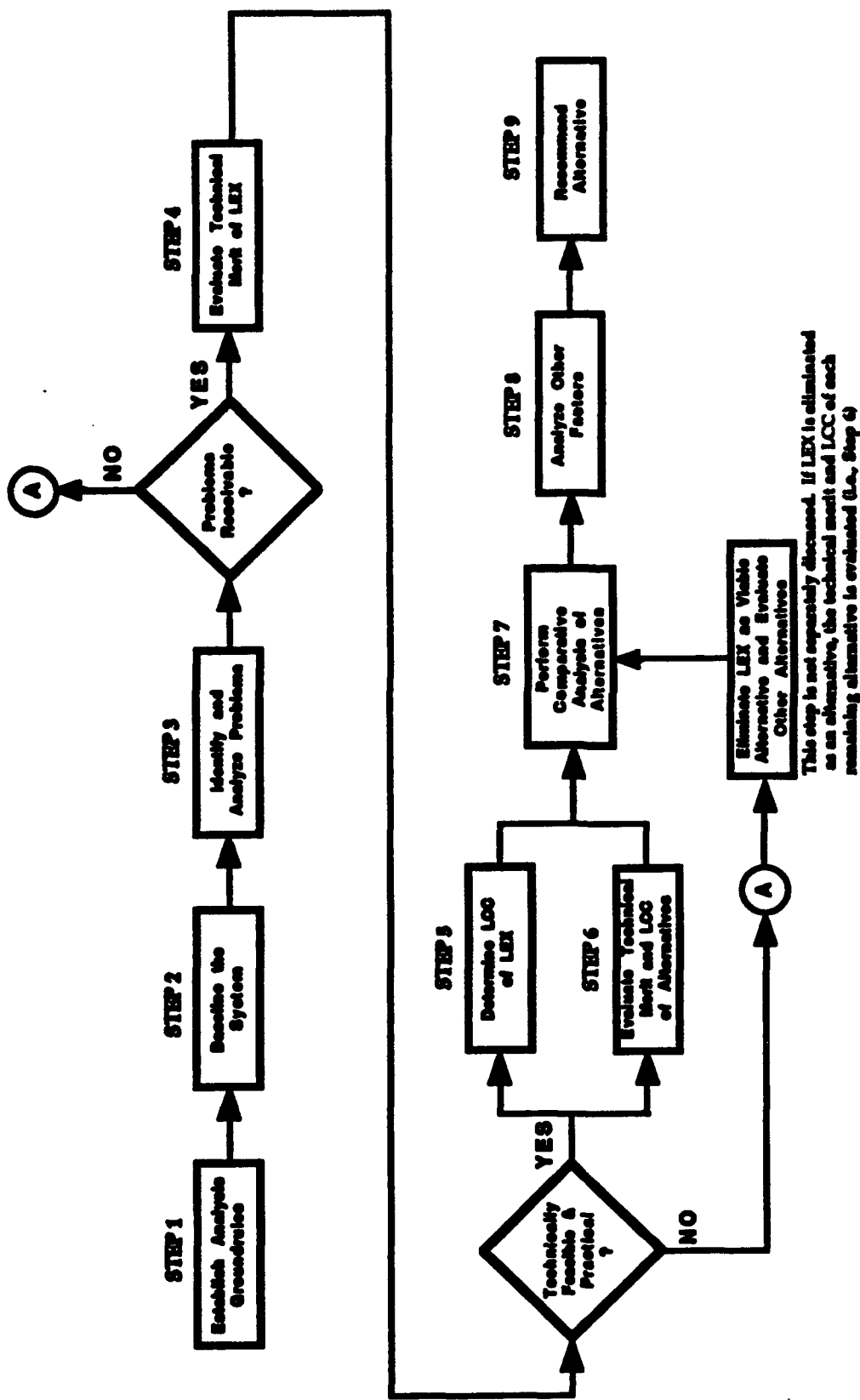
Seals

**Components with
Chemical Reactions**

- Batteries
- Propellants
- Some capacitors

Protective Coatings

- Paint
- Anodizing
- Plating



Flow Chart of a Generalized Life Extension Assessment Process

CAPABILITY APPLICATIONS

- **MISSILE SYSTEMS**
- **UTILITY INDUSTRY**
- **HEAVY EQUIPMENT**
 -
 -
 -
- **ANY CAPITAL INTENSIVE ACQUISITION WHERE EXISTING
HARDWARE AT OR NEAR END OF LIFE**

RAC ROLE:

- **Publisher of guidance book**
- **Applier of assessment approach**



GENERIC SENSOR PACKAGE S&T ASSESSMENT FOR THE OFFICE OF NAVAL RESEARCH

Prepared by

**James S. McCasland
Battelle Memorial Institute**

and

**Larry W. Williams, Ph.D.
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Approved for Public Release: Distribution Unlimited

[The final report for this study is Limited Distribution and/or Classified.]

CONTEXT

- SUPPORT TO DoD S&T THRUST 2: PRECISION STRIKE, S&T THRUST 3: AIR SUPERIORITY AND DEFENSE, S&T THRUST 4: SEA CONTROL, AND S&T THRUST 5: ADVANCED LAND COMBAT
- RELEVANT TO DoD KEY TECHNOLOGY 3: SENSORS
- DoD MILITARY MISSIONS/FUNCTIONS: GROUND FORCES/CLOSE AIR SUPPORT, TACTICAL LAND-BASED AIR FORCES, TACTICAL SEA-BASED AIR FORCES
- THE PURPOSE OF THIS EFFORT WAS TO CREATE A POINT PAPER FOR ONR TO BE REVIEWED BY NAVAIR, AND THE ENTITIES WHICH ADDRESSED THE POTENTIAL FOR A GENERIC SENSOR PACKAGE WHICH COULD BE UTILIZED IN CURRENT AND FUTURE NAVAL AIRFRAMES (S3, P3, F/A-18, F-14, ANY NGW START)

Prepared by: J. McCasland-Battelle/
L. W. Williams-TWSTIAC

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CONTEXT (Continued)

- THE INPUT FOR THIS OVERALL EFFORT CAME FROM TWO MAJOR SOURCES (1) EXTERNAL TO THE GOVERNMENT (INDUSTRY) AND (2) INTERNAL TO THE GOVERNMENT (LARS, NAWC, WPAFB, ARDA, ETC.)
- INDUSTRY RESPONSE WAS SOLICITED IN THE TRADITIONAL CBD APPROACH
- TWSTIAC WAS TASKED TO SUPPORT THE INTERNAL RESPONSE

Prepared by: J. McCasland-Battelle/
L. W. Williams-TWSTIAC

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TWSTIAC TASK

- THE KIND OF INSIGHTS SOUGHT BY ONR IN THIS EFFORT WOULD HELP ADDRESS/ANSWER QUESTIONS SUCH AS:
 - (1) With the threats/targets/environment currently envisioned are there current on-going sensor developments that should be singled out and pushed (fully funded), which would result in a very significant improvement that would translate to much higher leverage on the battlefield?
 - (2) Given the status of current developments, what would be the results of waiting 5 years as technology progressed and then providing funding for Engineering & Manufacturing Development to achieve high leverage in (1) above?
 - (3) Same as (2), but delay 10 years
- SENSOR DEVELOPMENTS ADDRESSED TO INCLUDE ALL SERVICES AND ALL SENSOR AREAS (ACQUISITION, STRIKE, ETC.)

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TWSTIAC TASK (Continued)

- **HELP IDENTIFY THOSE SENSOR DEVELOPMENTS THAT NOT ONLY SHOW PROMISE BUT ALSO THOSE EFFORTS THAT WOULD SHOW PROMISE IF BETTER PROGRAM INTEGRATION WERE EXERCISED**

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TWSTIAC METHODOLOGY

- DATA COLLECTION

- Data collection for sensor S&T assessments consisted of visits to Government labs/offices and documentation review. The two prime sources in each area are:

- Visits: NAWC Warminster
- Documents: Fiscal year 1994 (FY 94) Joint Service Program Plan Technology Panel for Sensors (JDL-TDSE)

- DATA ANALYSIS

- Sensor development project efforts were reviewed and assessed by TWSTIAC experts in each area of endeavor (radar, IR, laser, Etc.) providing their perspectives and insights

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TWSTIAC METHODOLOGY

(Continued)

- **DATA SYNTHESIS**
 - Armed with the viewpoint/perspectives of the results of the data analysis a review of the goals/priorities/schedule in a project related to similar efforts as well as efforts that used a different technology or different approach but were trying to achieve the same end results. Program integration between services relative to each service's project priorities was a big factor in the synthesis

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APPROACH

- **EARLY IN THIS EFFORT IT WAS EVIDENT THAT THE FUTURE WORLD IN WHICH WE MIGHT HAVE TO CONDUCT BATTLEFIELD OPS HAD TO BE NARROWED TO A TARGET MATRIX THAT WAS REPRESENTATIVE BUT NOT SO BIG THAT THE STUDY WOULD GET BOGGED DOWN.**
- **THE MAIN SOURCES OF INFORMATION WERE AS DESCRIBED ABOVE**
- **THE "NEW" INFORMATION THAT RESULTED FROM THIS ASSESSMENT WAS THE IDENTIFICATION OF THOSE SENSOR DEVELOPMENTS EFFORTS THAT HAD "BREAK- THROUGH POTENTIAL" RELATIVE ACHIEVING HIGH BATTLEFIELD LEVERAGE AGAINST THE THREAT MATRIX MENTIONED ABOVE.**

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SUMMARY OF DATA

- **FOURTEEN CATEGORIES OF SENSOR DEVELOPMENTS WERE ADDRESSED IN THE FOLLOWING SUBAREAS:**

- **Airborne Wide Area Surveillance (WAS) Radar (ZANF)**
- **OTH Land Based Radar**
- **Wide-Area Surveillance Electro-Optic(EO)**
- **Air-Air/Air-Surface Radar**
- **Strike Radar (ZANF)**
- **Nap-of-Earth Radar**
- **Anti-Submarine Warfare**
- **Surface-Surface, Surface-to-Air Radar (Sea Based)**
- **Air-Air and Air-Surface Electro-Optics**
- **Anti-Surface Electro-Optics (ZANF) (Joint)**
- **Anti-Surface Electro-Optics (Individual Services)**
- **Surface-Surface/Surface-Air Electro-Optics (Sea Based)**
- **Automatic Target Recognition (ATR) Technology**
- **JDL Multi-Color IR Technology Working Group**

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SUMMARY OF DATA

(Continued)

- **IN SOME CASES WHOLE CATEGORIES DID NOT CONTAIN DEVELOPMENTS ORIENTED TO THE GENERIC SENSOR PACKAGE THREAT MATRIX (TELS, TBMS, VLO TGTS) SUCH AS ANTI-SUBMARINE WARFARE**
- **ALL WERE ASSESSED FOR AIR PLATFORM CARRIAGE**
- **OUT OF THE ABOVE A TOTAL OF 62 SPECIFIC DEVELOPMENTS OR GROUPINGS OF DEVELOPMENTS HAD POTENTIAL FOR PROVIDING A DIRECT OR INDIRECT POSITIVE INFLUENCE**

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RESULTS OF DATA ANALYSIS

- THE SENSOR DEVELOPMENT PROGRAM/PROJECT ENDEAVORS WERE ASSESSED WITH RESPECT TO THEIR "BREAK-THROUGH POTENTIAL" RELATIVE TO PRODUCING THE KIND OF PERFORMANCE IMPROVEMENTS THAT COULD RESULT IN THE BATTIFIELD LEVERAGE PREVIOUSLY MENTIONED
- SOME OF THESE EFFORTS WERE NOT CLEAR-CUT BLACK/WHITE DECISIONS. FOR EXAMPLE SOME EFFORTS THAT WERE EVALUATED AS HIGH AGAINST VLO AIR TARGETS WERE EVALUATED AS LOW AGAINST THE REST OF THE THREATS (TBMS, TELS). ALSO SOME EFFORTS EXHIBITED GOOD (HIGH) ATTRIBUTES FOR ONE PARTICULAR FACTOR SUCH AS SENSOR-TO-SENSOR KEYING BUT FELL DOWN IN OTHER AREAS. THE "BREAK-THROUGH POTENTIAL" THAT THESE EFFORTS WERE ASSIGNED WAS BASED ON THEIR POTENTIAL TO CONTRIBUTE TO THE ENTIRE THREAT MATRIX

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RESULTS OF DATA ANALYSIS

(Continued)

- THE SIXTY-TWO (62) EFFORTS ASSESSED WERE EVALUATED AS FOLLOWS

Break-through Potential Assessment Rating

Number

| | |
|---------------|----|
| High | 14 |
| Moderate-high | 16 |
| Moderate | 4 |
| Low-moderate | 10 |
| Low | 18 |

- FOR EACH DEVELOPMENT EFFORT THE GOAL/OBJECTIVE AND TIME FRAME FOR COMPLETION WAS STATED

CONSEQUENCES

- **FULL IMPACT OF THIS EFFORT WILL NOT BE CLEARLY EVIDENT UNTIL ONR'S INTERNAL ASSESSMENT CAN BE ADDRESSED IN CONTEXT WITH THE INDUSTRIAL RESPONSE**
- **BENEFITS TO DOD WILL COME IN THE VISIBILITY TO ADDRESS AND PROVIDE PROGRAM INTEGRATION WHERE IT IS NEEDED TO MAKE THINGS HAPPEN**
- **THE ABOVE WILL IN TURN PROVIDE THE COST SAVINGS TO NAVAIR IN TERMS OF IDENTIFYING THE MOST EFFECTIVE TECHNOLOGY INFUSION PROGRAMS TO PURSUE**
- **ACCELERATION AND SUCCESSFUL COMPLETION OF PROGRAM MILESTONES**
- **REVIEW OF OPERATIONS PURSUANT TO SENSOR CAPABILITIES EXISTENT ON A LARGER VARIETY OF AIRFRAMES/PLATFORMS**

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RELEVANCE TO OTHER USERS

- **AS "NEW START" PROGRAMS BECOME FEWER AND HARDER TO IMPLEMENT, THIS TYPE OF EXERCISE WILL BE IMPORTANT ACROSS ALL DOD SERVICES AND WEAPON SYSTEMS**
- **THIS TYPE OF ENDEAVOR HIGHLIGHTS WHERE "PROGRAM INTEGRATION" IS NEEDED IN ADDITION TO ADDRESSING THE TECHNICAL MERITS OF A PARTICULAR DEVELOPMENT**

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MISSION ANALYSIS OF FUTURE ENHANCED SURVIVABILITY SHIP PLATFORMS

Prepared by

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Approved for Public Release: Distribution Unlimited

[The final report for this study is Limited Distribution and/or Classified.]

CONTEXT

- S&T THRUST 4: SEA CONTROL
- DoD MILITARY MISSIONS/ROLES/FUNCTIONS: SEA CONTROL AND ASW

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Future Navy Operations

"When that war (i.e., Desert Storm) is over, we must continue to forge a national policy that is consistent with and fosters the new world order. It will be especially important for the Department of the Navy to be realistic about expected sources and force structure. Nevertheless, we will continue our vital contribution in stability and security on the seas and throughout the littoral regions of the world."

**The Secretary of the Navy's
Posture Statement, Feb, 1991**

In other words, the U.S. Navy will have to:

- **Operate in wider range of situations and locations,**
 - **with existing platform classes**
 - **with fewer platforms,**
 - **against threats employing a wider vareity of doctrines**
 - **against threats with greater technological diversity**

PURPOSE

- **ANALYZE THE MILITARY WORTH OF READILY AVAILABLE RADAR CROSS SECTION (RCS) REDUCTIONS ON EXISTING COMBATANT VESSELS**
 - **Phase I - Against Soviet threat**
 - **Phase II - Against Third World threats, U.S. force operating without air cover**

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Potential Areas of Crises



Ref: "1991 Joint Military Net Assessment", Mar 1991 JCS, (U)

Scenarios for Mission Analysis

A set of scenarios is selected for study - derived from 1991 Joint Military Net Assessment by JCS/J-5, and which includes:

- **Major regional contingency (e.g., Korea or SWA). Mid to High intensity; 120 days of combat**
- **Lesser regional contingency - Low to Mid intensity: 90 days of combat**
- **Counter-insurgency/counter-narcotics (Central America, South America and/or Republic of Philippines)**
- **War escalating from a European crisis. Mid to High intensity; more than 50 days of combat.**

NOTE: Scenarios are valuable for testing the credibility of realistic environments, natural or assumed.

Regional Conflict, Southern Med (Libya)

- **U.S. organizes SAG Naval cruise missile strike force as part of UN security council resolution to conduct operations against hardened libyan air land targets to neutralize capability to bases on Libyas southern border with Chad.**
- **No U.S. carriers in Med. They have been committed to hostilities in Korea.**
- **U.S. action would begin by SAG approaching hostile country coastline within approximately 100 NMI to launch cruise missiles at military installations; airfields, factories, A/C parking lots, revetments, ammo depots, etc.**
- **SAG will defend against sea and land-based missile batteries and aircraft launched weapons with AEGIS missile weapon system.**

Libyan Strike I

U.S. Objective -

Conduct TLAM-C strike on air bases in southern Libya, to be followed by UK-French/UN Coalition air strikes.

U.S. Forces -

SAG, consisting of:

(3) DDG-51

(1) CG-52

(1) DD-963 (VLS)

AEW:

(1) E-3A (AWACS)

Libyan Forces -

Bombers/Fighter Bombers:

(4) TU-22 Blinder (used for reconnaissance w/RF Link to)

(24) Mirage F-1, 5D

Submarines:

(4) Foxtrot (Diesel-Electric) Submarines

(14) Libyan surface missile craft

TWSTIAC APPROACH

PHASE I

- **UTILIZE STANDARD SCENARIOS**
 - **CVBG attacked by ALCMs & SLCMs**
 - **Leakers engaged by AEGIS and Ship Self-Defense System**
- **ANALYZE EFFECT OF ACHIEVABLE RCS REDUCTION ON CVBG SURVIVABILITY**

PHASE II

- **DEVELOP SCENARIOS FOR POST-COLD WAR ENGAGEMENTS**
 - **SAG attacked by ALCMS and missile boats**
 - **Missiles engaged by AEGIS & Ship Self-Defense System**
- **ANALYZE EFFECT OF ACHIEVABLE RCS REDUCTION ON SAG SURVIVABILITY**

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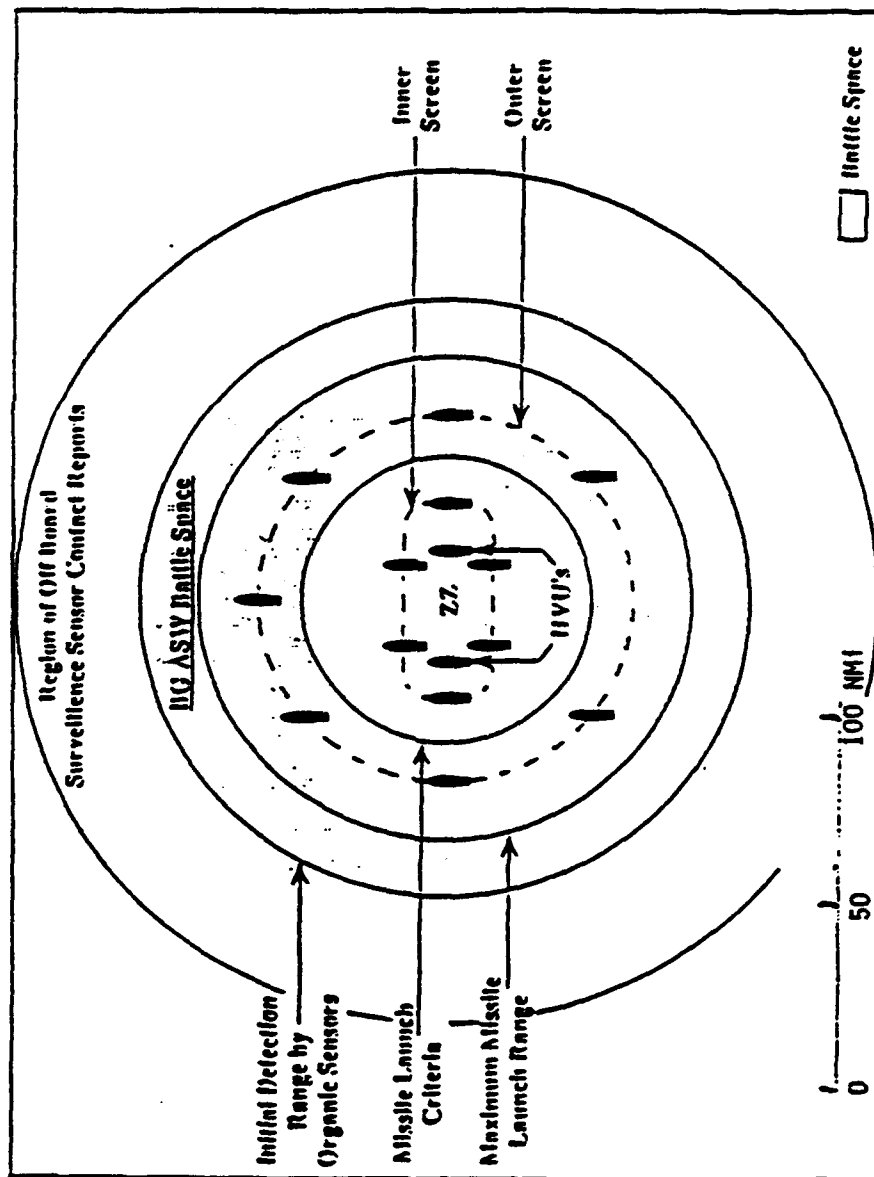
TWSTIAC METHODOLOGY

- REVIEW EXISTING SCENARIOS (FOR PHASE I)
- DEVELOP NEW SCENARIOS BASED ON J-5 INPUTS (FOR PHASE II)
- OBTAIN SYSTEM PERFORMANCE PARAMETERS FROM DATABASE
- DEVELOP VALUES FOR ACHIEVABLE RCS REDUCTION
- CALCULATE P
S FOR EXISTING AND REDUCED RCS PLATFORMS,
BASED ON
 - Defensive hard kill
 - Defensive softkill
 - Synergistic effects
- PROVIDE RECOMMENDATIONS
 - Classified recommendations made to DARPA

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(UNCLASSIFIED)

RESULTS

- **READILY ACHIEVABLE RCS REDUCTIONS FOUND BENEFICIAL IN ENHANCING SHIP SURVIVABILITY IN BOTH SCENARIOS**
- **SHIP SURVIVABILITY IS FURTHER ENHANCED BY INTEGRATION OF ACTIVE AND PASSIVE DEFENSIVE MEASURES**

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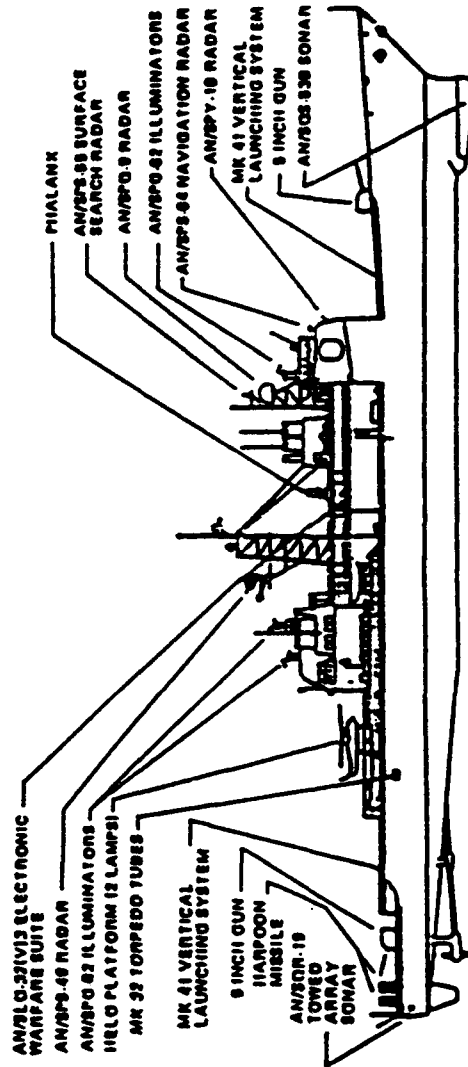
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Ship Characteristics (CG 64)

LENGTH..... 567 FEET
BEAM..... 55 FEET
SPEED..... 30 + KNOTS
DRAFT (KEEL)..... 23.2 FEET

DRAFT (NAVIGATION)..... 32 FEET
DISPLACEMENT..... 9,616 TONS
ACCOMMODATIONS..... 37 OFFICERS
45 CHIEF PETTY OFFICERS
327 ENLISTED



PROPULSION

4 LM2500 GAS TURBINE ENGINES, 80,000 SHAFT HORSEPOWER
2 CONTROLLABLE REVERSIBLE PITCH PROPELLERS
2 RUDDERS

SENSORS

1 AN/SPY-1B RADAR (FOUR ARRAYS)
1 AN/SPS-48 AIR SEARCH RADAR
1 AN/SPS-55 SURFACE SEARCH RADAR
1 AN/SPS-64 NAVIGATION RADAR
1 AN/SPG-9 SURFACE SURVEILLANCE AND TRACKING RADAR
4 AN/SPG-62 ILLUMINATORS
1 AN/SOR-19 TOWED-ARRAY SONAR
1 AN/SOS-136 SONAR
1 AN/SLO-32(V)3 ELECTRONIC WARFARE SUITE

WEAPONS

1 MK 7 MOD 4 AEGIS WEAPONS SYSTEM
2 MK 45 8"/74 CALIBER LIGHTWEIGHT GUN MOUNTS
2 MK 41 VERTICAL LAUNCHING SYSTEMS (VLS)
2 HANPOON MISSILE QUAD-CANNISTER LAUNCHERS
2 MK 32 MOD 14 TORPEDO TUBES
1 MK 16 MOD 12 CLOSE-IN WEAPONS SYSTEM (2 MOUNTS)
1 MK 38 MOD 6 SUPER RAPID-BLOOMING OFF BOARD CHAFF SYSTEM
4 50 CALIBER MACHINE GUNS

COMMAND AND CONTROL

MK 1 MOD 0 AEGIS DISPLAY GROUP

AIRCRAFT

2 LAMPS MK III (SH-60B)

CONSEQUENCES

- **STUDY BRIEFED TO OPNAV**
- **OPNAV REQUESTED ADDITIONAL ANALYSES FROM DARPA TO SUPPLEMENT THEIR SHIP SELF-DEFENSE STUDY**
- **ADDITIONAL EFFORT NOT UNDERTAKEN DUE TO SHIFT OF INTEREST IN DARPA**

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GROUND COMBAT FORCES

**EVALUATION OF LIGHTWEIGHT INTEGRATED SUIT
TECHNOLOGIES (LIST) AND ASSOCIATED TEST
METHODS**

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **ADVANCED LAND COMBAT (S&T THRUST)**
 - **Rapid Force Deployment**
 - **Tactical Mobility**
 - **Quick Mission Accomplishment**
 - **Minimal Casualties Against Heavy Armor and Smart Weaponry**
- **NBC ENVIRONMENT LIKELY**
 - **Proliferation**
 - **Biotechnology Advances**
 - **Affects Battlefield Dynamics**
 - **Survivability**
 - **Performance Degradation**
 - **Support**

IAC TASK

- **WHAT**
 - **Resolve Issues Resulting from the use of two Different Test Methods to Evaluate Protective Clothing**
 - **Validate without Polyethylene Film Test**
 - **Correlate with and without Film Methods**
 - **Fill Critical Gaps in Database for Current and Developing Material Technologies**
 - **Determine the Effects of Wearing Suits Upon Levels of Protection Provided**
- **WHY**
 - **Improved Protective Capabilities Needed**
 - **Reduction in Heat Stress**
 - **Reduction in Logistical Support Requirements**
 - **More Sensitive Test Method Needed**
- **WHO**
 - **U.S. Army**

IAC METHODOLOGY

- **PERFORM SIDE BY SIDE COMPARISONS OF TEST METHODS**
 - **Test Worn Suit Materials using both Methods**
- **ATTEMPT TO CORRELATE TEST RESULTS**

RESULTS

- **WORN LIGHTWEIGHT SUIT MATERIALS SHOWN TO PROVIDE ADEQUATE LEVELS OF CHEMICAL AGENT RESISTANCE**
- **DATA GENERATED USING DIFFERENT METHODS COULD NOT BE CORRELATED**
- **"RELATIVE" RANKINGS OF SUIT MATERIALS FOUND TO BE SIGNIFICANTLY DIFFERENT DEPENDING UPON METHOD USED**
- **TESTING WITHOUT FILM FOUND TO BE MORE SENSITIVE AND A BETTER METHOD FOR QUANTIFYING THE EFFECTS OF WEAR**

CONSEQUENCES

- **PROVIDED VALUABLE GUIDANCE FOR WEAR AND LOGISTICAL SUPPORT OF LIGHTWEIGHT CLOTHING DURING OPERATION DESERT STORM (ODS)**
- **WITHOUT PE FILM ADOPTED AS THE U.S. STANDARD SWATCH TEST METHOD FOR MATERIALS EVALUATION**
- **STANDARDIZED QUALITY CONTROL AND QUALITY ASSURANCE METHODS FOR EVALUATION OF CHEMICAL PROTECTIVE CLOTHING MATERIALS**
- **EVOLUTION OF JOINT SERVICES PROGRAM - JSLIST**

RELEVANCE TO OTHER USERS

- **ORGANIZATIONS RESPONSIBLE FOR ESTABLISHING STANDARDS AND TEST METHODS FOR CHEMICAL PROTECTIVE CLOTHING (CPC)**
 - **ASTM**
 - **ISO**
- **TESTERS OF CPC**
- **USERS OF CPC**
 - **Hazmat Teams**
 - **Department of Transportation (DOT)**
 - **Department of Energy (DOE)**
 - **Manufacturers of Hazardous Chemicals**

MEDTAG
CONCEPT EVALUATION AND PROTOTYPE
DEVELOPMENT PLAN

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **ADVANCED LAND COMBAT (S&T THRUST)**
 - **Rapid Force Deployment**
 - **Tactical Mobility**
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- **NBC ENVIRONMENT LIKELY**
 - **Proliferation**
 - **Biotechnology Advances**
 - **Affects Battlefield Dynamics**
 - **Survivability**
 - **Performance Degradation**
 - **Support**

- **WHAT**
 - **Evaluate and Demonstrate the Technical Feasibility of the MEDTAG Concept**
- **WHY**
 - **Problems Associated with Present Practice - The Field Medical Card (FMC)**
 - **Rarely Implemented**
 - **Too Slow**
 - **Poor Data Quality -- Errors and Obliterations**
 - **Need for Capability in CBW Environments and Extreme Weather Conditions**
 - **Limitations Associated with Current Pilot Programs - Requirement for Interface Device -- Reader/Writer**
- **WHO**
 - **U.S. Naval Health Research Center**

IAC METHODOLOGY

- **REFINE REQUIREMENTS**
- **SELECT AND EVALUATE TECHNICAL ALTERNATIVES**
- **DEVELOP PROOF-OF-CONCEPT VERSION OF MEDTAG**
- **DEMONSTRATE BASIC TECHNICAL FEASIBILITY OF MEDTAG CONCEPT**
- **DEVELOP PLAN AND OPTIONS FOR MEDTAG**
 - **Miniaturization and Ruggedization**

RESULTS

- **PROOF-OF-CONCEPT UNIT DESIGNED AND DEVELOPED**
- **PROOF-OF-CONCEPT DEMONSTRATED**
 - **Data Entry Time Reduced - Seconds Versus Minutes**
 - **Data Entry Accuracy Improved - Interactive Data Dictionary**
- **MINIATURIZATION AND RUGGEDIZATION PLANS DEVELOPED**

CONSEQUENCES

- **DEVELOPMENT OF VIABLE APPROACH FOR IMPROVING BATTLEFIELD MEDICAL CARE**
- **POTENTIAL FOR INCREASED SURVIVABILITY OF MILITARY FORCES**

RELEVANCE TO OTHER USERS

- **ALL SERVICES**
- **ALLIES**
- **CIVILIAN EMERGENCY MEDICAL SERVICES**

RELEVANCE TO OTHER USERS

- **ALL SERVICES**
- **ALLIES**
- **CIVILIAN EMERGENCY MEDICAL SERVICES**

DESIGN AND ANALYSIS OF A LOW SPEED DRAG PLOW FOR DEEP SNOW

Presented by

**Peter D. Smallidge
CECRL-ORTA**

Authored by

**Michael R. Walsh, CECRL-TE, and Paul W. Richmond, CECRL-EA
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Approved for Public Release: Distribution Unlimited

CONTEXT

- DOD MILITARY MISSIONS / FUNCTIONS
 - Ground Forces
 - » Mobility, Logistics, and Supply
 - Force projection
 - Low intensity conflict

Prepared by: P. D. Smallidge

IAC PLOW-1

IAC TASK / BASIC INFORMATION PRODUCT

- **USER PROBLEM / REQUIREMENT**
 - Winter logistics operations for Army field units in Alaska hampered by deep snow
 - Existing equipment:
 - » 2-1/2 ton truck
 - » HMMWV
 - » SUV
 - Develop snow clearing device for support off-road winter exercises with wheeled vehicles
- **IAC PRODUCT FOCUS**
 - Review snow handling options
 - Evaluate snow / terrain conditions
 - Literature and patent search on plow technology

SUMMARY OF FINDINGS

- **SNOW HANDLING OPTIONS**
 - Compaction
 - Blowing / throwing
 - Melting
 - Plowing
- **SNOW / TERRAIN CHARACTERISTICS**
 - Low density snow, 1 meter deep
 - Terrain is uneven with brush, hummocks, and fallen trees
- **PLOW TECHNOLOGY**
 - V-Shaped drag plow
 - SUSV adaptable to plow technology

Prepared by: P. D. Smallidge

IAC PLOW-3

CONSEQUENCES

- **LABORATORY AND MODEL STUDIES TO DEVELOP PLOW AND TOW MECHANISM DESIGNS**
- **FIELD EVALUATION OF HALF AND FULL-SCALE MODELS**
 - Snow depths to 1 meter
 - Within SUSV operating parameters
- **PATENTS ON PLOW AND TOWING MECHANISMS**

RELEVANCE TO OTHER USERS

- **TOWED SLEDS**

- SUSV in Alaska
- Challenger in Antarctica
- Soft ground / marshes

- **FARMING APPLICATIONS**

Prepared by: P. D. Smallidge

IAC PLOW-5

SMART WEAPONS OPERABILITY ENHANCEMENT (SWOE) PROGRAM

Presented by

**Peter D. Smallidge
CECRL-ORTA**

Program Manager

**Dr. James P. Welsh, CECRL-SW
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Approved for Public Release: Distribution Unlimited

CONTEXT

- **DOD SCIENCE AND TECHNOLOGY THRUST**
 - Synthetic Environments: Provide computer- and electronics-based technology for development, testing, training and readiness to synthesize factory-to-battlefield environments.
 - Precision Strike: Against critical mobile and fixed targets in all-weather; day/night; and foliage- and camouflage-resistant environments.
- **DOD KEY TECHNOLOGY**
 - Environmental Effects: The automated generation of near-real-time environmental tactical decision aids to determine the adverse effects of dynamic battlefield environments on characterization and modeling of military requirement and operations.
- **DOD CRITICAL TECHNOLOGY**
 - Simulation and Modeling
 - Weapon System Environment

IAC TASK / BASIC INFORMATION PRODUCT

- **ARMY TECHNOLOGY BASE MASTER PLAN**
 - Science and Technology Objective, VI.C.5., Smart Weapons Operability Enhancement
 - » Develop analytical IR and MMW models to robustly simulate geographical and time/weather driven character of environmental scenes.
 - » Develop validated multi-sensor scene generation capability for quantitative consideration of environmental conditions in the design, test and evaluation of smart weapon and ATR devices.
- **IAC PRODUCT FOCUS**
 - Survey and analyze environmental science technologies to support development of an integrated, physics based, scene generation process.
 - » Measurement and Information Bases
 - » Analytical Models
 - » Scene Rendering Software
 - Customer:
 - » OSD Joint Test & Evaluation Program
 - » U.S. Army Smart Weapons Management Office
 - » Individual Emerging Systems

SELECTED PRODUCTS SWOE PROGRAM

- 88-1, Program Implementation Plan, USACRREL, Jan 89
- 90-1, One-Dimensional Temperature Modeling Techniques, EG&G Energy Measurements / SPARTA / NASA Goddard Space Flight Center, Aug 90
- 90-8, Representative Weather Data Sets for Hunfeld, Federal Republic of Germany, USAASL, Jul 90
- 90-9, Comparison of Climatologies of Selected SWOE Test Sites, USAASL, Aug 90
- 90-15, Three Dimensional Modelling of Background Scenes at Millimeter Waves, MIT Research Lab. of Electronics, Dec 90
- 92-1, Information Base Procedures for Generation of Synthetic Thermal Scenes, USAEWES, Feb 92
- 92-2, Review of Environmental Research Specific to SWOE for the Battlefield Environment, USACRREL/USATEC/ USAEWES, Jun 92
- 92-6, Data Analysis for Bark and Leaf Reflectance Measurements, Spectral Sciences, Inc./Phillips Lab., Jun 92
- 93-1, A Review of Millimeter Wave Modeling, USACRREL, Mar 93

Prepared by: P. D. Smallidge

IAC SWOE -3

IAC METHODOLOGY

- **DATA BASES**
 - Survey environmental data from military test sites
 - Analyze for
 - » Validity
 - » Range of relevant conditions
- **MODELS**
 - Initial survey of sensor models relevant to smart weapons - IR and MMW
 - Survey and compilation of IR models
 - Workshop to establish / synthesize MMW techniques
- **SIMULATION**
 - Survey government and commercial technologies
 - Evaluate based on smart weapon system drivers / parameters

SUMMARY OF FINDINGS

- **PERFORMANCE OF SMART WEAPONS SYSTEMS HAS BEEN UNPREDICTABLE AND UNRELIABLE FOR EXTRAPOLATION TO THE GLOBAL RANGE OF BATTLEFIELD CONDITIONS.**

- Effects of the environment are treated in generic rather than specific ways.
- There are no environmental criteria for development or testing. The environment is not defined in terms relevant to the performance of smart weapons.
- Environment performance criteria are not keyed to the specific regions within which that system must operate.

- **OPTIONS TO SOLVE THE PROBLEM**

- Real imagery data
- Hybrid imagery
- Synthetic imagery

CONSEQUENCES

- **RECOMMENDED APPROACH:**
 - Validated scene generation process
 - » Integrated physics based models
 - » Terrain and weather data base driver
 - » Workstation environment
 - Compatibility with Distributed Interactive Simulation
- **RESULT:**
 - Smart Weapon Operability Enhancement Joint Test & Evaluation (SWOE JT&E) program initiated in 1992, \$15.2M funding, 3 years
 - Impact: Early consideration of environment in design, optimization of testing, extrapolation of test results

RELEVANCE TO OTHER USERS

- **PHYSICAL SECURITY SYSTEMS**
 - Sensor performance design and evaluation
 - Criteria for logic design to reduce false alarms
- **REMOTE SENSING**
 - Mission planning
 - Image analysis criteria
 - New sensor design / evaluation

Prepared by: P. D. Smallidge

IAC SWOE -7



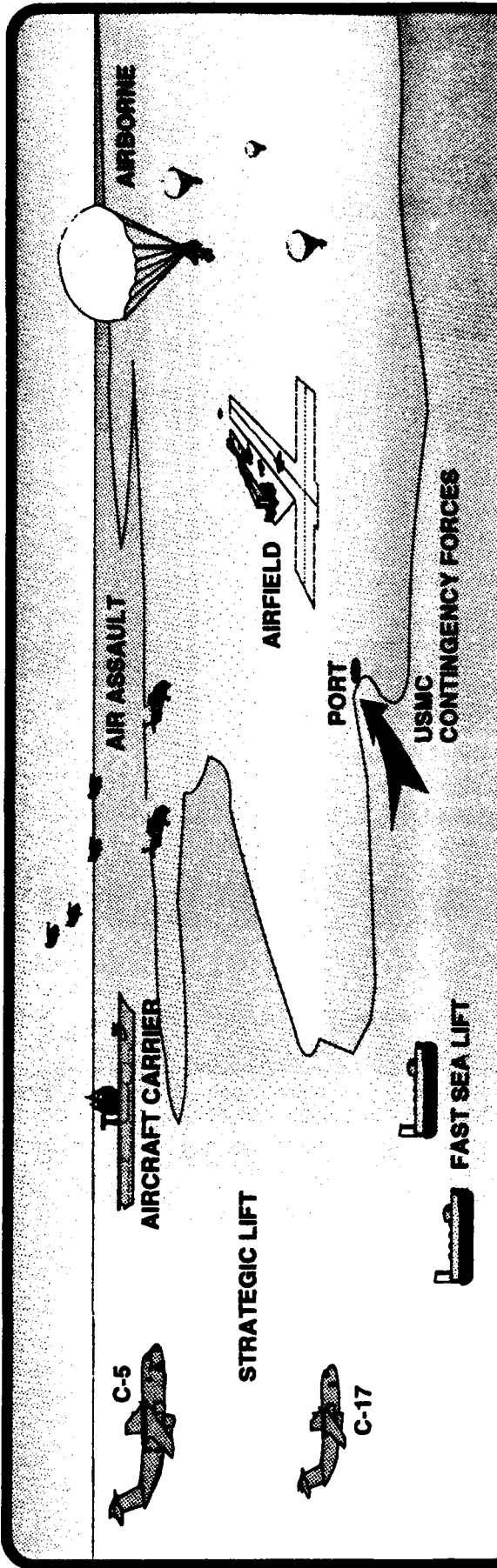
ADVANCED LAND COMBAT

PREPARED BY

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ADVANCED LAND COMBAT CONTEXT



DESCRIPTION

- ABILITY TO RAPIDLY DEPLOY GROUND FORCES TO A REGION
- EXERCISE A HIGH DEGREE OF TACTICAL MOBILITY
- OVERWHELM THE ENEMY QUICKLY WITH MINIMAL CASUALTIES
- IN THE PRESENCE OF A HEAVY ARMORED THREAT AND SMART WEAPONRY
- REQUIRES HIGHLY CAPABLE LAND COMBAT SYSTEMS

Presented By: **GACIAC**
DR. NARYAN MURARKA

STRATEGIC MOBILITY

AIRLIFT - C-5/C-141/C-17
SEALIFT - PREPOSITIONED FAST

TACTICAL MOBILITY

AIRBORNE/SOF/RANGERS
AIR ASSAULT - BLACKHAWK
CH-47/SPECIAL AIRCRAFT
GROUND VEHICLES
M1A2/M2A1/AGS/HMMWV
AIR VEHICLES
APACHE/COMMANCHE
UAVs - CR, SR ENDURANCE

CAPABLE LAND COMBAT FORCES

EQUIPPED WITH HIGH TECHNOLOGY WEAPON SYSTEMS

SMART WEAPONS

TOW/TSP
WAM

HELLFIRE II
JAVELIN
NLOS

SADARM
APACHE LONGBOW
BAT P31
ATACMS P31

MAVERICK
SFW
LASER GUIDED MUNITIONS
AMRAAM

ADVANCED LAND COMBAT MODELING / SIMULATION IAC TASKS

GACIAC SPECIAL TASKS

- GENESIS
 - SMART WEAPONS MANY-ON-MANY MODEL
 - FOCUSES ON SUBMUNITION ENDGAME ANALYSIS
 - VISUALLY DEPICTS SUBMUNITION FLYOUT/FOOTPRINT SEARCH
 - USEFUL IN EVALUATING NEW CONCEPTS/SYSTEM P31
- SADARM ONE-ON-ONE SIMULATION DEVELOPED TO SUPPORT PM
- BAT P31 ANALYSIS IS USING GENESIS TO EVALUATE GENERIC SEEKER CAPABILITY AND VARIOUS P31 ALTERNATIVES
- HARDWARE-IN-THE-LOOP SIMULATION USED TO EVALUATE STINGER AIR DEFENSE SEEKER CAPABILITY
- PM SURVIVABILITY SYSTEMS HAS USED GENESIS TO EVALUATE THE IMPACT OF ELECTRONIC COUNTERMEASURES ON BLUE GROUND VEHICLE SYSTEMS
- GENESIS MODEL USED TO ASSESS THE IMPACT OF COUNTERMEASURES ON SMART WEAPON SYSTEMS - SADARM/MLRS-TGW

**MODELING/SIMULATION SUPPORTS THE DEVELOPMENT OF KEY SYSTEMS
FOR ENHANCING LAND FORCE CAPABILITY**

ADVANCED LAND COMBAT SMART WEAPONS

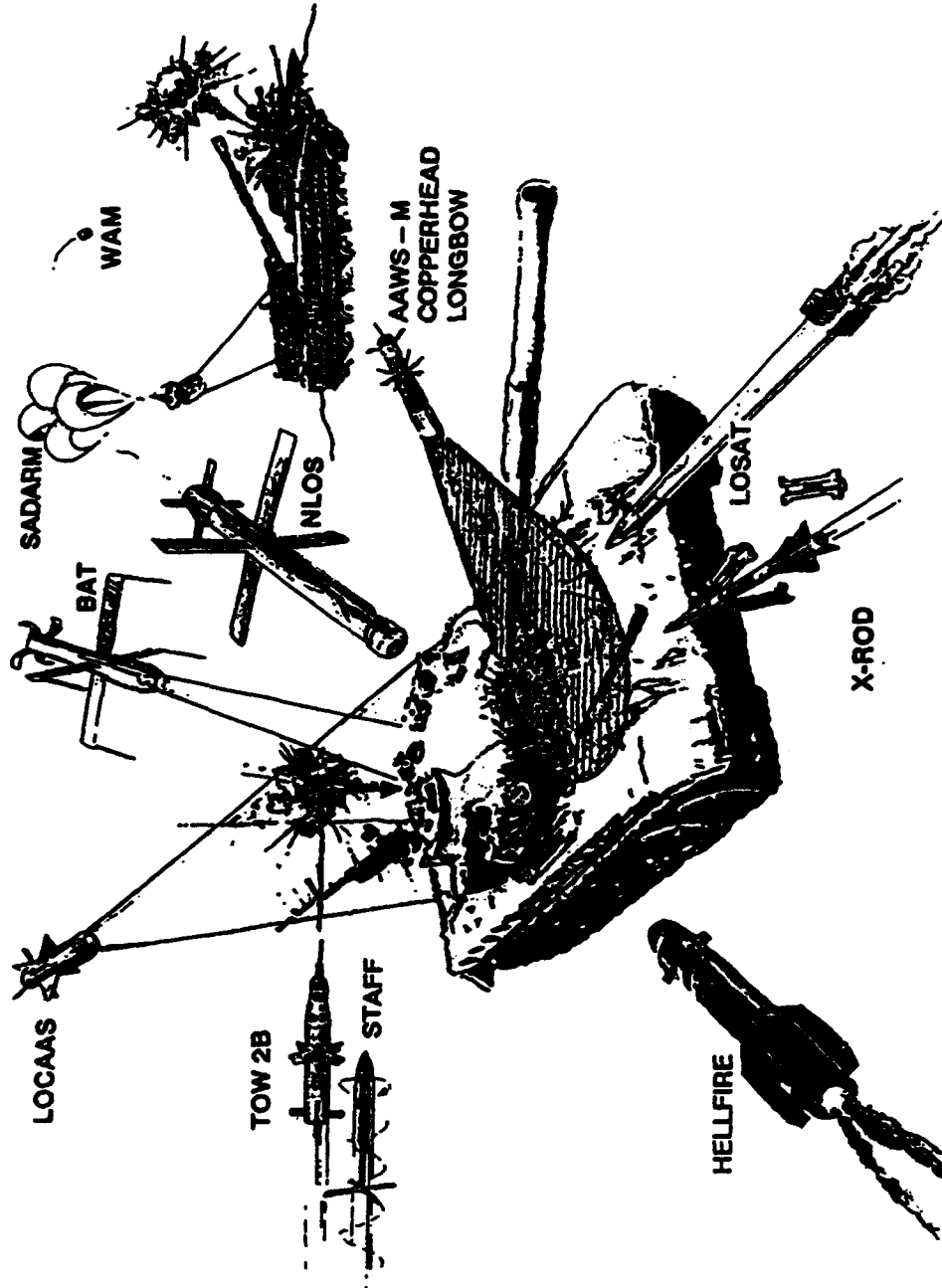
GACIAC SPECIAL TASKS

- TOW 2B - PERFORMANCE AND COUNTERMEASURE TESTING
- SADARM - MODELING/SIMULATION AND COUNTERMEASURE TESTING (CHICKEN LITTLE) AND ASSESSMENT
- WAM - ACOUSTIC ANALYSIS
- STAFF - COUNTERMEASURE ASSESSMENT
- JAVELIN - COUNTERMEASURE ANALYSIS
- HELLFIRE - INDEPENDENT AERODYNAMIC ANALYSIS
- MLRS-TGW - COUNTERMEASURE EFFECTIVENESS ANALYSIS
- BAT P³I - ANALYSIS OF P³I ALTERNATIVES, MODELING AND ANALYSIS OF P³I WITH ATACMS P³I
- NLOS - COUNTERMEASURE ASSESSMENT
- APACHE LONGBOW - COUNTERMEASURE ASSESSMENT
- CHICKEN LITTLE - SMART WEAPONS SENSOR/SEEKER AND COUNTERMEASURE TESTING

**GACIAC SPECIAL TASKS PROVIDE TECHNICAL SUPPORT FOR SMART
WEAPON DEVELOPMENTS**



ANTI-ARMOR MUNITIONS ATTACK



ADVANCED LAND COMBAT DATABASES

- TARGET SIGNATURE DATABASES
 - TOWER TESTING
 - CAPTIVE FLIGHT
 - SENSOR/SEEKER TYPES
 - ELECTRO-OPTICAL
 - IR
 - MMW
 - DUAL MODE
 - ACOUSTIC
 - LADAR
- COUNTERMEASURE EFFECTS
 - SIGNATURE SUPPRESSION
 - DECOYS
 - OBSCURANTS
 - JAMMING
- AMC-SWMO - IDENTIFIES SIGNATURE REQUIREMENTS
 - ENSURES REPROGRAMMABILITY
- CHICKEN LITTLE - TABILS
- FSTC - THREAT/SCALE MODELS VEHICLES FOR SIGNATURE USE
- ARGUS - DoD INTEGRATION OF SERVICE DATABASES

DATABASES ECONOMICALLY SUPPORT TRI-SERVICE SYSTEM DEVELOPMENT



ADVANCED LAND COMBAT PRODUCTS / VALUE

- GACIAC SUPPORTS AMC-SMART WEAPONS MANAGEMENT OFFICE (AN INTEGRATOR FOR SMART WEAPONS DEVELOPMENT)
 - MANAGES/PRIORITIZES SIGNATURE REQUIREMENTS
 - ENSURES SMART WEAPONS REPROGRAMMABILITY
 - DEVELOPED SMART WEAPONS CM/CCM ASSESSMENT METHODOLOGY
- MODELING/SIMULATION SUPPORTS AND EXPEDITES SYSTEM DEVELOPMENT
- CHICKEN LITTLE ARMY/AIR FORCE JOINT PROGRAM PROVIDES A REALISTIC TEST ENVIRONMENT FOR SMART WEAPONS
- SMART WEAPONS PROVIDE LAND FORCES THE CAPABILITY TO EXECUTE THEIR MISSION RAPIDLY WITH MINIMAL CASUALTIES, SUCH AS IN DESERT STORM

**IN THE ERA OF DECREASED DEFENSE SPENDING, GACIAC PROVIDES
"ECONOMIES OF SCALE" FOR DoD**





TACTICAL LAND FORCES

SMART WEAPONS COUNTERMEASURES STUDIES

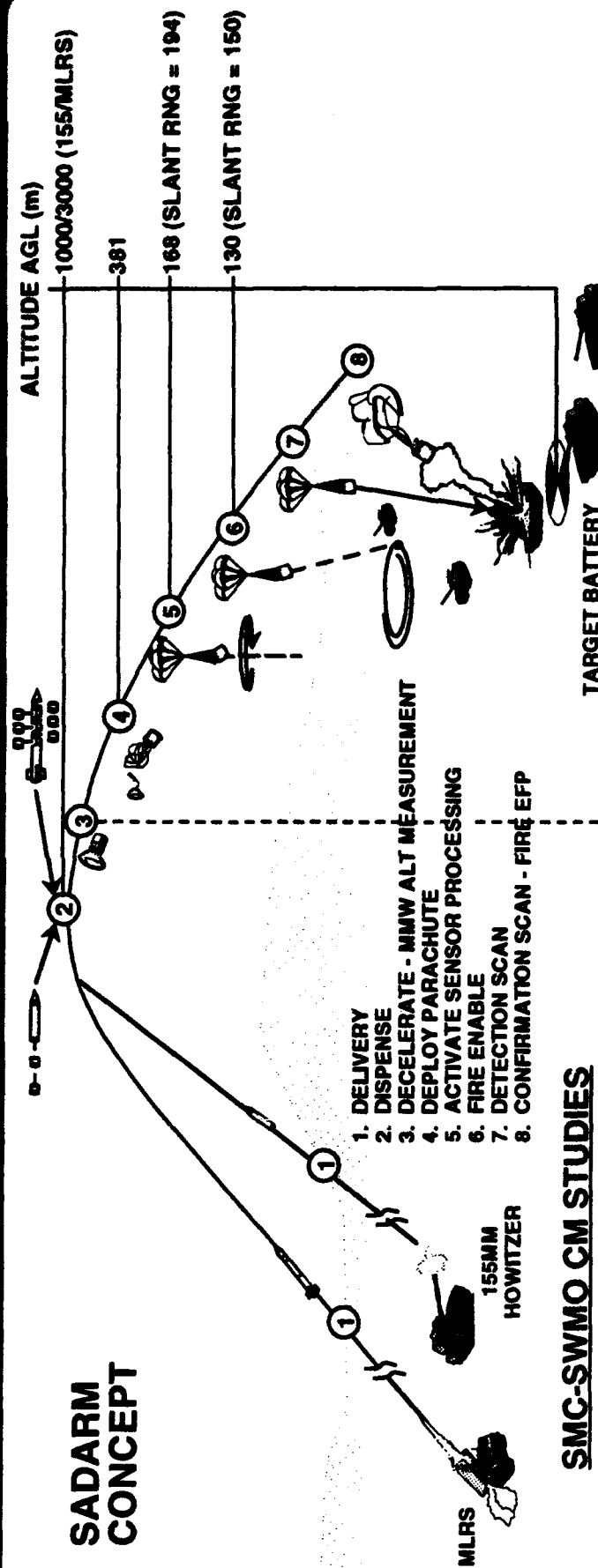
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UNCLASSIFIED

TACTICAL LAND FORCES CONTEXT SMART WEAPONS COUNTERMEASURE STUDIES

SADARM CONCEPT



SMC-SWMO CM STUDIES

• DESIGNED TO ASSIST SW MATERIEL AND COMBAT DEVELOPERS IN UNDERSTANDING HOW CMs AFFECT SW PERFORMANCE

• CM STUDIES INCLUDE:

- VOLUME I: GUIDE TO HOW COUNTERMEASURES AFFECT SMART WEAPONS
- VOLUME II: EFFECTS OF COUNTERMEASURES ON SMART WEAPON TECHNOLOGY
- VOLUME III: CM/CCM ANALYSIS OF SMART WEAPON SYSTEMS
- VOLUME IV: GUIDE TO ARMY SMART WEAPON TESTING ISSUES

Presented By: DR. NARYAN MURARKA

CM/CCM ANALYSIS OF SMART WEAPON SYSTEMS

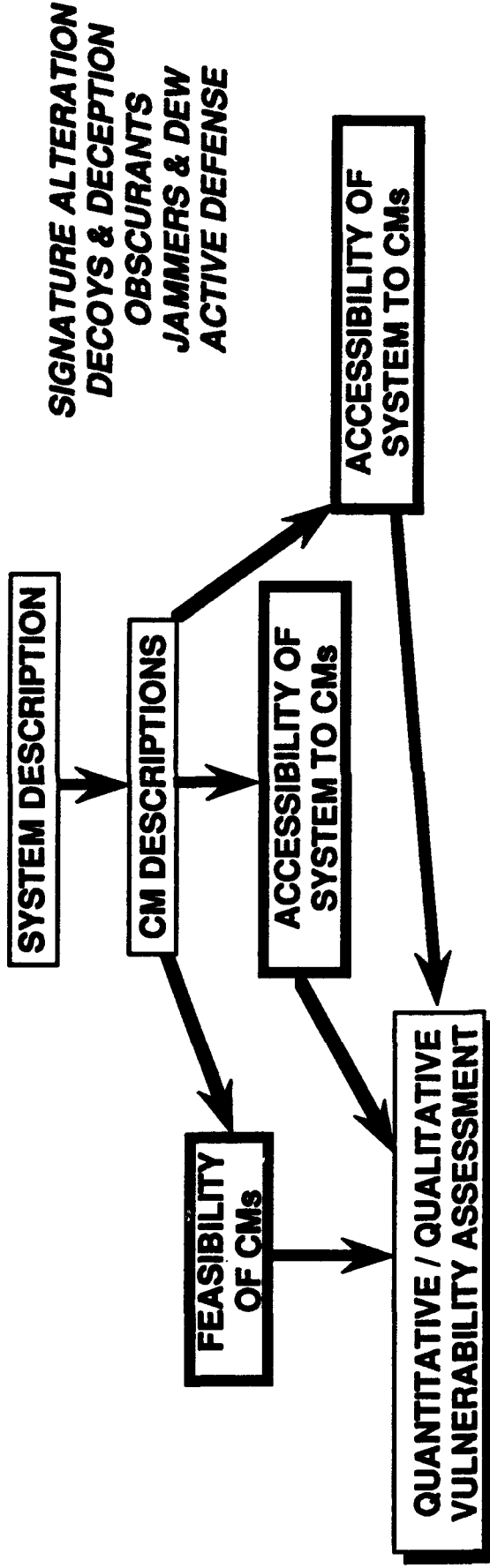
CM VOLUME III CONSISTS OF AN EXECUTIVE SUMMARY AND FIVE INDIVIDUAL SUBVOLUMES

- VOLUME III-A: SENSE AND DESTROY ARMOR (SADARM)
- VOLUME III-B: SMART TARGET-ACTIVATED FIRE-AND-FORGET (STAFF)
- VOLUME III-C: NON-LINE OF SIGHT (NLOS)
- VOLUME III-D: MULTIPLE LAUNCH ROCKET SYSTEM - TERMINAL GUIDANCE WARHEAD (MLRS-TGW)
- VOLUME III-E: GENERIC LADAR ANTI-ARMOR SYSTEM (GLAAS)

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SMART WEAPONS COUNTERMEASURE STUDIES ASSESSMENT METHODOLOGY

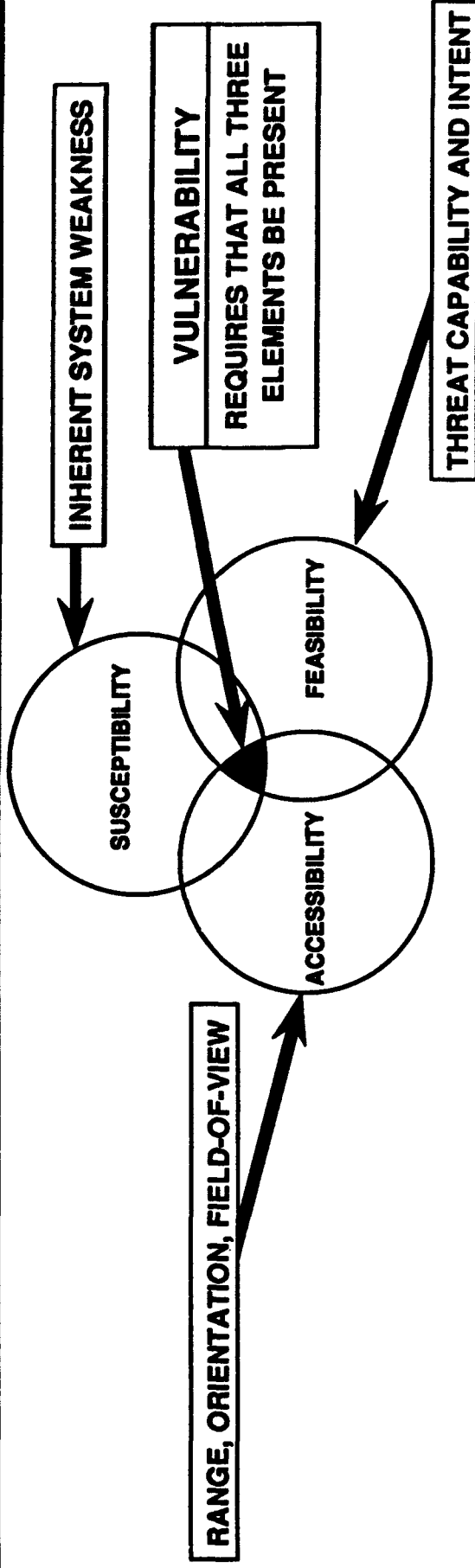


- CM/CCM ANALYSIS WAS DESIGNED TO DETERMINE HOW SMART WEAPONS WOULD PERFORM IN A CM ENVIRONMENT
- SYSTEM DESIGN AND INHERENT CCM FEATURES WERE TAKEN INTO ACCOUNT
- A DETAILED LISTING OF CMs THAT AFFECT THE SYSTEM AND THE NATURE OF THEIR EFFECTS WERE ASSESSED

**GACIAC DEVELOPED A CM/CCM ANALYSIS METHODOLOGY
FOR ASSESSING SMART WEAPONS VULNERABILITY**



SMART WEAPONS COUNTERMEASURE STUDIES SYSTEM VULNERABILITY



- VENN DIAGRAM ILLUSTRATES THE CONCEPT OF INTEGRATING THE KEY ASPECTS OF SYSTEM VULNERABILITY
- SUSCEPTIBILITY IS THE SYSTEM'S INHERENT WEAKNESS
- FEASIBILITY IS AN ASSESSMENT OF THREAT CAPABILITY AND INTENT
- ACCESSIBILITY ADDRESSES THE GEOMETRY OF THE ENGAGEMENT FROM A RANGE, ORIENTATION, FIELD-OF-VIEW

**SYSTEM COUNTERMEASURE VULNERABILITY CAN BE DETERMINED BY
INTEGRATING SUSCEPTIBILITY, FEASIBILITY, AND ACCESSIBILITY**



SMART WEAPONS COUNTERMEASURE STUDIES EVALUATION OF CMs BY FUNCTIONAL CLASS

| COUNTERMEASURES | ELEMENTS / KEY CONSIDERATIONS | RATING |
|---|--|--|
| <ul style="list-style-type: none"> • SIGNATURE ALTERATIONS <ul style="list-style-type: none"> • SUPPRESSION • AUGMENTATION • DECOYS / DECEPTION <ul style="list-style-type: none"> • LOW FIDELITY • HIGH FIDELITY • OBSCURANTS <ul style="list-style-type: none"> • CONVENTIONAL • BISPECTRAL • MULTISPECTRAL • JAMMERS / DIRECTED ENERGY WEAPONS <ul style="list-style-type: none"> • JAMMERS • SELF-PROTECT • ESCORT • SEMI • DEW • HIGH ENERGY LASERS • HIGH POWERED MICROWAVE • ACTIVE SELF-PROTECTION | <ul style="list-style-type: none"> • ELEMENTS <ul style="list-style-type: none"> • SUSCEPTIBILITY • FEASIBILITY • ACCESSIBILITY • VULNERABILITY • KEY CONSIDERATIONS <ul style="list-style-type: none"> • CURRENT CAPABILITY • FUTURE CAPABILITY | <p>HIGH</p> <p>MODERATE</p> <p>LOW</p> <p>VERY LOW</p> |

SMART WEAPONS CM/CCM ASSESSMENT METHODOLOGY PROVIDED
A RIGOROUS APPROACH TO EVALUATE EACH APPLICABLE CM AND FUNCTIONAL CLASS OF CMs

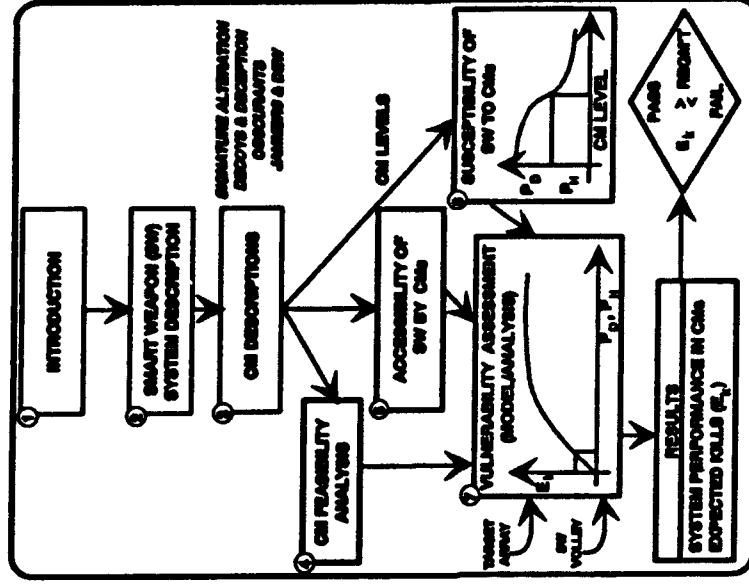


SMART WEAPONS COUNTERMEASURE STUDIES QUALITATIVE/QUANTITATIVE VULNERABILITY ASSESSMENTS

| CM | FEASIBILITY | ACCESSIBILITY | SUSCEPTIBILITY | VULNERABILITY |
|----|-------------|---------------|----------------|---------------|
| #1 | ● | ● | ● | ● |
| #2 | ● | ○ | ● | ○ |
| #3 | ○ | ○ | ● | ○ |
| #4 | ○ | ○ | ○ | ○ |
| #5 | ○ | ○ | ○ | ○ |

LEGEND: ● HIGH ○ MODERATE ○ LOW ○ VERY LOW

- **SYSTEM VULNERABILITY SHOULD NOT EXCEED THE RATING OF ITS LOWEST ELEMENT AND CAN BE LOWER**
- **FOR THESE REASONS SYSTEM VULNERABILITY IS USUALLY LESS THAN ITS SUSCEPTIBILITY**



DEPENDENT ON DEGREE OF SYSTEM MATURITY, EITHER QUALITATIVE JUDGEMENTS ARE MADE OR QUANTITATIVE VULNERABILITY ASSESSMENT MADE WITH TEST/MODELING DATA

SMART WEAPONS COUNTERMEASURE STUDIES PRODUCTS/VALUE

- **FOUR CM VOLUMES WILL ASSIST MATERIEL AND COMBAT DEVELOPERS TO UNDERSTAND HOW CMs AFFECT SMART WEAPON PERFORMANCE**
 - VOLUME I: GUIDE TO HOW COUNTERMEASURES AFFECT SMART WEAPONS
 - VOLUME II: EFFECTS OF COUNTERMEASURES ON SMART WEAPON TECHNOLOGY
 - VOLUME III: CM/CCM ANALYSIS OF SMART WEAPON SYSTEMS
 - VOLUME IV: GUIDE TO ARMY SMART WEAPON TESTING ISSUES
- **VOLUME III PROVIDES DETAILED CM ASSESSMENTS OF SPECIFIC SYSTEMS/ TECHNOLOGY AND APPLIES THE CM/CCM ASSESSMENT METHODOLOGY**
 - VOLUME III-A SENSE AND DESTROY ARMOR (SADARM)
 - VOLUME III-B SMART TARGET-ACTIVATED FIRE-AND-FORGET (STAFF)
 - VOLUME III-C NON-LINE OF SIGHT (NLOS)
 - VOLUME III-D MULTIPLE LAUNCH ROCKET SYSTEM--TERMINAL GUIDANCE WARHEAD (MLRS-TGW)
 - VOLUME III-E GENERIC LADAR ANTI-ARMOR SYSTEM (GLAAS)
- **PMs GET THE BENEFIT OF A DETAILED CM ASSESSMENT WHICH EVALUATES THE ROBUSTNESS OF THE SYSTEM TO CMs**
 - CCM EFFORTS CAN BE IDENTIFIED FOR FUTURE P3I
 - SYSTEM REPROGRAMMABILITY REQUIREMENTS CAN BE IDENTIFIED TO IMPROVE PERFORMANCE
- **RESULTS PUBLISHED IN GACIAC SPECIAL REPORT (GACIAC SR 93-01)**

**AMC-SWMO HAS A RIGOROUS SMART WEAPON CM/CCM ANALYSIS
METHODOLOGY FOR USE IN ANALYZING OTHER SMART WEAPON SYSTEMS**



**COMPUTERIZATION OF PROPERTIES OF
AUSTEMPERED DUCTILE IRON (ADI)**

Prepared by

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Approved for Public Release; Distribution is Unlimited

CONTEXT

- **BROAD OBJECTIVE OF DOD S&T THRUST AREA ON ADVANCED LAND COMBAT**
 - The ability to rapidly deploy our ground forces to a region, exercise a high degree of tactical mobility, and overwhelm the enemy quickly and with minimal casualties in the presence of a heavy armored threat and smart weaponry requires highly capable land combat systems.
- **BROAD OBJECTIVE OF DOD KEY TECHNOLOGY AREA ON MATERIALS AND PROCESSES**
 - The DoD Materials and Processes technology area spans the spectrum of structural, thermal protection, non-structural, and electronic materials. Cost-effective, integrated manufacturing technology is implicitly included in each of the above materials areas.
- **DOD MILITARY MISSION/FUNCTION**
 - Ground Forces
 - Domestic Technology Transfer

MIAC TASK/INFORMATION PRODUCT

- **SUBSET OF DOD MILITARY MISSION/FUNCTION**
 - **Armor/systems**
 - o **Track System for M1/A1 Tank and Bradley Vehicle**
 - **Artillery/systems**
 - o **155 mm Shell Bodies in M864 Artillery Round**
- **MIAC TASK/INFORMATION PRODUCT FOCUS**
 - **What: Collect and computerize existing information/data on physical and mechanical properties of Austempered Ductile Iron (ADI)**
 - **Who: U.S. Army Research Laboratory Materials Directorate**
 - **Form: Computerized PC-based numeric database on properties of ADI**

MIAC METHODOLOGY

- **METHODOLOGY EMPLOYED**
 - Data compilation from articles published in worldwide literature
 - o Chemistry
 - o Processing
 - o Testing
 - o Properties
 - Data analysis and computerization
 - Development of interactive, menu-driven, pc-based numeric database
- **APPROACH**
 - **MIAC Uniqueness**
 - o Experience in numeric database development
 - o Ability to analyze data
 - **Existing Information**
 - o Published information and data are analyzed and compiled in computer readable format
 - **New Information**
 - o Analyzed and compiled data in a PC-based numeric database

SUMMARY OF DATA

- **DATA COMPILATION**
 - **Compiled datasets covering properties of ADI**
 - o **Mechanical Properties**
 - **Tensile/compressive behavior**
 - **Hardness and toughness**
 - **Fatigue**
 - **Impact and wear**
 - o **Physical Properties**
 - **Retained Austenite**
 - **Nodularity and melt chemistry**
 - **Hardenability**
 - **Damping response**
- **CHARACTERISTICS**
 - **Data depend strongly on chemistry and processing**

RESULTS

- **FINDINGS RESULTING FROM DATA ANALYSIS**
 - **Properties of ADI depend strongly on chemistry, thermal history, and processing**
 - **Specification standards are available only in U.S. and Japan**
 - **Many ADI producers do not adhere to established standards**
- **TECHNICAL RECOMMENDATIONS**
 - **Establish MIL SPEC standards**
 - **Tight control of chemistry and processing for desired properties**

CONSEQUENCES

- **WHAT WILL HAPPEN AS A RESULT OF THE COMPLETION OF THIS MIAC PRODUCT**
 - **Computerized pc-based numeric database on properties of ADI will help evaluate its applications**
 - o **Supporting Research on ADI**
 - **Financial Benefits to DoD**
 - o **Cut production cost**
 - o **Increase in lifetime of parts**
 - **Other Benefits to DoD**
 - o **Improvement in existing armored vehicle designs**
 - o **Reduced acoustic signature (Improved stealth)**
 - o **Tougher, longer lasting, more dependable parts**

RELEVANCE TO OTHER USERS

- **RELATED SUBSTANTIVE PROBLEMS FOR WHICH MIAC PRODUCT WOULD BE RELEVANT**
 - Currently there is no comprehensive source of information on ADI
 - Numeric database on properties of ADI is also useful to industry
 - o Automotive manufacturers
 - o Machine, gear manufacturers
 - o Foundries
- **ANALOGOUS PROBLEMS FOR WHICH MIAC PRODUCT WOULD BE RELEVANT BECAUSE OF THE METHODOLOGY USED**
 - Data collection and analysis methodology applicable to a broad range of materials
 - o HSLA Steel
 - o Super Alloys
 - o Intermetallics

**FAILURE ANALYSIS ON ELECTROSLAG REMELT
(ESR) 4340 STEEL**

Prepared by

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Approved for Public Release; Distribution is Unlimited

CONTEXT

- **BROAD OBJECTIVE OF DOD S&T THRUST AREA ON ADVANCED LAND COMBAT**
 - The ability to rapidly deploy our ground forces to a region, exercise a high degree of tactical mobility, and overwhelm the enemy quickly and with minimal casualties in the presence of a heavy armored threat and smart weaponry requires highly capable land combat systems
- **BROAD OBJECTIVE OF DOD KEY TECHNOLOGY AREA ON MATERIALS AND PROCESSES**
 - The DoD Materials and Processes technology area spans the spectrum of structural, thermal protection, non-structural, and electronic materials. Cost-effective, integrated manufacturing technology is implicitly included in each of the above materials areas
- **DOD MILITARY MISSION/FUNCTION**
 - Ground Forces
 - Domestic Technology Transfer

Prepared by: Pramod D. Desai

MIAC - 2b

MIAC FOCUSED BIBLIOGRAPHIC SEARCH

- **SUBSET OF DOD MILITARY MISSION/FUNCTION**
 - **Close Air Support**
 - o **Mixer Pivot Support for the AH-64 Apache Helicopter**
- **FOCUS: BIBLIOGRAPHIC SEARCH FOR PROPERTY DATA ON SPECIFIC MATERIALS**
 - **What: Provide Information on Failure of Electroslag Remelt (ESR) 4340 Steel**
 - **Who: Army Research Laboratory Materials Directorate, Watertown, Massachusetts**
 - **Form: Compilation of Evaluated Pertinent Information from Published Literature**

MIAC METHODOLOGY

- **METHODOLOGY EMPLOYED**

- Computer search of all available information on failure of ESR 4340 was conducted
- Information sources were gathered and analyzed for content and usefulness
- All pertinent information was organized, packaged and delivered

- **SPECIAL PROVISIONS**

- Literature collection was to encompass all information readily available to MIAC
- Results needed to be prepared for delivery within 6 hours

SUMMARY OF DATA

- **LITERATURE INFORMATION COLLECTED**
 - **Over 300 pages of relevant information was analyzed and prepared for overnight delivery within six hours of the inquiry request**
- **Characteristics**
 - **Failure was analyzed as a function of stress, temperature, environment and processing**

RESULTS

- **FINDINGS RESULTING FROM ANALYSIS**
 - **Failure mode of ESR 4340 steel under various conditions**
- **TECHNICAL RECOMMENDATIONS**
 - **Using the information provided by MIAC, Army Research Laboratory Materials Directorate made recommendations on the inspection interval and method as well as material processing to ensure the safe operation of the AH-64 Apache helicopter**

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS MIAC INQUIRY?**
 - **MIAC's ability to complete task on short notice enabled the Army to quickly analyze and address the problems being faced by the Apache helicopter in Operation Desert Storm**
 - **Financial Benefits to DoD**
 - o **Saved Time - MIAC was able to secure all the background information in less than 24 hours**
 - o **Saved money by their not having to search and acquire all documents of possible interest**
 - o **Savings from having a better search done by skilled information specialist**
 - **Other Benefits to DoD**
 - o **Apache helicopter will have less down time for repair**
 - o **Apache helicopter will be safer to fly**
 - o **Other applications of ESR 4340 could benefit from the material provided**

RELEVANCE TO OTHER USERS

- **RELATED SUBSTANTIVE PROBLEMS FOR WHICH MIAC PRODUCT WOULD BE RELEVANT**
 - This and other information generated by similar technique would be of interest to anyone who designs, builds, tests, or specifies military hardware
 - Information would also be of interest to designers of automobiles and other equipment that uses ESR 4340
- **ANALOGOUS PROBLEMS FOR WHICH MIAC PRODUCT WOULD BE RELEVANT BECAUSE OF THE METHODOLOGY USED**
 - Methodology used in this work for the collection and analysis of materials' bibliographic information can be used for any materials and properties

NTIAC

NONDESTRUCTIVE EVALUATION APPLICATIONS FOR STRATEGIC FORCES AND MISSIONS

Prepared by

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Approved for Public Release: Distribution Unlimited

Prepared by: Gary W. Carriveau

NTIAC - 1

CONTEXT

- **NONDESTRUCTIVE EVALUATION AND INSPECTION OF MATERIALS AND SYSTEMS HAS BEEN IDENTIFIED AS A DOD CRITICAL TECHNOLOGY**
- The objective of this task is to identify NDE methods, associated information collection techniques, and appropriate applications which can be made available to U.S. Special Operations Command, Component Special Operations Forces, and other U.S. Light Infantry Forces

Prepared by: Gary W. Carriveau

NTIAC - 2

NTIAC TASK FOCUS

- **LIGHT INFANTRY AND SPECIAL OPERATIONS FORCES OF THE DOD ARE OFTEN CALLED UPON TO OPERATE IN FORWARD AREAS WITH LITTLE OR NO LOGISTICAL SUPPORT.**
- **ESTABLISHED NONDESTRUCTIVE EVALUATION METHODOLOGIES MAY PROVIDE IMPORTANT SELF-CONTAINED, PORTABLE, IN-FIELD APPLICATIONS FOR THE COLLECTION OF INFORMATION BEARING ON THE TACTICAL SITUATIONS CONFRONTING THESE FORCES.**
- **NTIAC was requested by the Defense Technical Information Center to perform an assessment of applicable NDE technologies and methodologies**
- **Assistance is to be provided in the form of a technology assessment and method development plan**

NTIAC METHODOLOGY

- **SOF MISSION ANALYSIS WITH REGARD TO POSSIBLE NDE METHODS**
- **SPECIFIC NDE APPLICATIONS FOR TACTICAL INFORMATION COLLECTION**
- **NDE HARDWARE/SOFTWARE REQUIREMENTS ANALYSIS**

Prepared by: Gary W. Carriveau

NTIAC - 4

SUMMARY OF DATA

- **RESULTS OF THE STUDY OF SOF MISSIONS AND POTENTIAL NDE APPLICATION**
- **STUDY OF APPROPRIATE NDE TECHNIQUES/METHODS**
- **REQUIREMENTS ANALYSIS AND TECHNICAL EVALUATION OF SENSORS, INTERFACE, DATA ANALYZERS (HARDWARE AND SOFTWARE), AND COMMUNICATIONS LINKS THAT ARE NEEDED**

Prepared by: Gary W. Carriveau

NTIAC - 5

ANALYSIS RESULTS

- **SUMMARY REPORT OF SOF MISSIONS AND FUNCTIONS WHERE NDE MAY BE APPROPRIATE**
- **SUMMARY REPORT OF POTENTIAL NDE TECHNIQUES/METHODS**
- **REQUIREMENTS ANALYSIS OF HARDWARE AND SOFTWARE REQUIRED**

Prepared by: Gary W. Carriveau

NTIAC - 6

EXPECTED RESULTS AT THE CONCLUSION OF THIS EFFORT

- **SUMMARY REPORT DESCRIBING POTENTIAL NDE APPLICATIONS IN
SUPPORT OF SOF MISSIONS**
- **REQUIREMENT STATEMENTS FOR NDE DEVELOPMENT IN SUPPORT
OF SOF MISSIONS**
- **IDENTIFICATION OF NDE TECHNOLOGY GAPS THAT MAY REQUIRE
FUTURE SUPPORT**

RELEVANCE TO OTHER USERS

- **RESULTS MAY BE USED TO INCREASE THE BREADTH OF TACTICAL INFORMATION COLLECTION TOOLS AND TECHNIQUES FOR ALL DOD COMPONENTS**
- **RESULTS WILL PROVIDE ADDITIONAL REQUIREMENTS INFORMATION TO DEVELOPERS OF SELF-CONTAINED, PORTABLE, IN-FIELD NDE HARDWARE/SOFTWARE**

Prepared by: Gary W. Carriveau

NTIAC - 8



NONDESTRUCTIVE TEST/EVALUATION ASSESSMENT IN SUPPORT OF TACTICAL LAND FORCES AND MISSIONS

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NTIAC - 1

CONTEXT

- **NONDESTRUCTIVE EVALUATION AND INSPECTION OF MATERIALS AND SYSTEMS HAS BEEN IDENTIFIED AS A DOD CRITICAL TECHNOLOGY**
- The objective of this task is to benchmark the status of Nondestructive Testing/Evaluation for applicability to the Composite Armored Vehicle (CAV) Advance Technology Demonstrator (ATD)
 - Users include:
 - Army Tank-Automotive Command and others involved in the development of such a vehicle
 - Other developers of "thick" composite components for vehicles and major assemblies (land, sea, air, space)

NTIAC TASK FOCUS

- **THE NEXT GENERATION COMPOSITE ARMORED VEHICLE CAN BENEFIT FROM A CONCURRENT ENGINEERING APPROACH WHICH INCLUDES NDE AT THE BEGINNING OF DESIGN CONSIDERATIONS**
- **NTIAC was requested by the U.S. Army Tank-Automotive Command to perform a detailed technology assessment on the state-of-the-art of NDE applied to "thick" polymer composites**
- **Assistance was provided in the form of a "study" and laboratory testing**

NTIAC METHODOLOGY

- **ESTABLISH THE BEST STATES OF PRACTICE FOR MATURE AND EMERGING TECHNOLOGIES**
- **DEFINE THE EXTENT THAT THESE TECHNOLOGIES ARE APPLICABLE OR MUST BE MODIFIED TO BE APPLICABLE TO CAV**
- **DEFINE THE SPECIFIC ROLE THAT THE TECHNOLOGIES MAY PLAY IN CAV DESIGN AND ATD FABRICATION**
- **COORDINATE THE TECHNOLOGY ASSESSMENT WITH WORK BEING DONE AT GOVERNMENT LABS, COMPOSITE CONSORTIA, UNIVERSITIES, AND PRIVATE INDUSTRY**

Prepared by: Gary W. Carriveau

NTIAC - 4

SUMMARY OF DATA

- **BIBLIOGRAPHIC SEARCH OF THE LITERATURE, 300 CITATIONS**
- **COLLECTION OF 148 PAPERS CITED IN THE SEARCH RESULTS, MOST WERE FOUND IN THE NTIAC DATABASE HOLDINGS**
- **DEVELOPMENT OF A "THICK" COMPOSITE DATABASE TO CATALOG AND TRACK PAPERS**
- **INFORMATION/DATA ACQUIRED THROUGH VISITS AND DISCUSSIONS WITH MATERIAL FABRICATORS, SYSTEM MANUFACTURES, TECHNIQUE/INSTRUMENT DEVELOPERS, RESEARCH LABORATORIES**

RESULTS OF ANALYSIS

- **FINAL TECHNICAL REPORT FROM "STUDY" PHASE**
- **IDENTIFICATION OF ADDITIONAL NEED; REQUEST FOR AN EXPANSION OF THE TASK TO INCLUDE LABORATORY ASSESSMENT FOR DIRECT COMPARISON OF PROMISING NDE TECHNOLOGIES**
- **RECOMMENDATIONS FOR MOST PROMISING NDE FOR APPLICATION TO THE CAV**
- **NTIAC STATE-OF-THE-ART REPORT**

Prepared by: Gary W. Carriveau

NTIAC - 6

EXPECTED RESULTS AT THE CONCLUSION OF THE EFFORT

- **IDENTIFICATION AND ASSESSMENT OF NDE TECHNOLOGY FOR THE
CAV ATD PROGRAM WITH POTENTIAL CONCURRENT ENGINEERING
APPLICATION TO:**
 - Improve combat effectiveness of advanced land vehicles
 - Optimize reduction of vehicle weight/increase reliability
 - Shorten acquisition time through better manufacturing process
control
- **A MUCH BETTER UNDERSTANDING OF NDE APPLIED TO "THICK"
POLYMER COMPOSITES**
- **STATE-OF-THE-ART REPORT**
- **PRESENTATION/PUBLICATIONS**

RELEVANCE TO OTHER USERS

- THE RESULTS WILL BE USEFUL TO ANYONE USING "THICK" COMPOSITES (LAND, SEA, AIR, SPACE) APPLICATIONS
- LABORATORY RESULTS WILL BE USED FOR FURTHER DEVELOPMENT OF NDE TECHNIQUES
- PROCESS CONTROL OF "THICK" COMPOSITES
- REPAIRABILITY & DURABILITY ISSUES

SURVIVABILITY SYSTEMS MASTER PLAN

Prepared by

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CONTEXT

- **SUPPORT THE DOD MILITARY GROUND FORCES WITHIN THE S & T THRUST AREA OF ADVANCED LAND COMBAT BY HELPING:**
 - **To Describe the Army's Plan for Achieving Survivability for Ground Combat Vehicles**
 - **To Provide a Source for Information on Developments in Ground Combat Vehicle Survivability**

SURVIVABILITY SYSTEMS MASTER PLAN

- **DOD MILITARY MISSIONS/FUNCTIONS**
 - **Advanced Land Combat**
- **SURVIAC TASK FOCUS**
 - **Document How the Program Manager Survivability Systems (PM-SS) Fits in Army Acquisition Programs**
 - **Publicize DoD Acquisition Plans and the Role of PM-SS**

SURVIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Consolidate Information on Technical Programs**
 - **Provide Consistency with DoD Acquisition Regulations**
- **APPROACH**
 - **Review and Evaluate Approaches on Previous Master Plans**
 - **Compile Programmatic Information, e.g., Cost, Performance, Technical Content**
 - **Interview Organizations Doing Technical Work on PM-SS Programs**
 - **Develop Methodology on How PM-SS Provides Information for New Programs**

SUMMARY OF DATA

- **DATA COLLECTED**
 - **Technical Program Details**
 - **Programmatic Plans**
 - **Materiel Acquisition Procedures**
- **DATA CHARACTERISTICS**
 - **Detailed Data on Individual Programs**
 - **Thrust Data to Reveal Overlaps and Voids**

RESULTS OF DATA ANALYSIS

- **FINDINGS SYNTHESIZED BY SURVIAC**
 - **Identified Data Gaps in Overall Program Areas**
 - **Aligned Programs with Program Milestones**
- **SUMMARY OF TECHNICAL RECOMMENDATIONS**
 - **Prepare Annual Updates**
 - **Continue to Disseminate Information on PM-SS Initiatives Through a Newsletter**

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS SURVIAC PRODUCT**
 - **Financial Benefits to DoD**
 - **Some Programs Were Rescoped, Reduced, or Eliminated**
 - **Other Benefits to DoD**
 - **Roadmap for PM-SS Technical Program and Information Resources is Available for Others**
 - **Changes in DoD Operations, Plans, or Procedures as a Direct Result of Product**
 - **More Efficient Use of Critical Program Resources**
 - **Enhanced Dissemination of Planned and On-Going Programs**

RELEVANCE TO OTHER USERS

- **INFORMATION DISSEMINATION APPROACH
APPLICABLE TO OTHER DOD ORGANIZATIONS
CONDUCTING MULTIPLE, INTERRELATED PROGRAMS**

**U.S. AIR FORCE SURFACE-TO-AIR
ENGAGEMENTS DURING OPERATION DESERT STORM**

Prepared by

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CONTEXT

- SUPPORT TACTICAL LAND- AND SEA-BASED AIR FORCES
SURVIVABILITY DESIGNS ENHANCING AIR SUPERIORITY BY:
 - Collecting and Preserving Data on Surface-To-Air Threat
Weapon System Encounters that Occurred During
Operation Desert Storm

U.S. AIR FORCE SURFACE-TO-AIR ENGAGEMENTS DURING OPERATION DESERT STORM

- **DOD S & T THRUST**
 - **Air Superiority**
- **SURVIAC TASK FOCUS**
 - **Collect and Analyze Data on Surface-To-Air Engagements from Operation Desert Storm**
 - **Preserve and Provide Data to be Used for Research by Military Services and Scientific Community**

SURVIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Data Collected Under the COARP (Combat Operations Assessment and Reporting Program)**
 - **Data Reported in "Red Baron" Type Format**
 - **Data Stored in a DoD Classified Database**
- **APPROACH**
 - **Rapidly Instituted COARP Data Collection Approach to Respond to Desert Storm**
 - **Applied Technique Used in Southeast Asia Battle Damage Assessment and Reporting Program (BDARP)**
 - **Developed Standardized Source Document for Data Collection**
 - **Trained Teams to Conduct On-Site Data Collection Interviews**

SUMMARY OF DATA

- **DATA COLLECTED**

- **Combat Incident Data on All USAF Surface-To-Air
Threat Encounters During Desert Storm**
- **Operations Information**
- **Damage and Effects Data**
- **Maintenance Records**

RESULTS OF DATA ANALYSIS

- **FINDINGS SYNTHESIZED BY SURVIAC**
 - **COARP Proved to be a Successful Combat Data Preservation Effort**
 - **Complied with Deputy Secretary of Defense Memo, 31 Jan 91 and AF Office of Assistant Secretary Memo, 5 Feb 91 to Preserve Combat Operations Data**
 - **Combat Data Critical to Improving the Capability of Fielded Systems**
 - **Data Preservation Vital to Design of Next Generation Systems that Are More Survivable and More Effective**
- **SUMMARY OF TECHNICAL RECOMMENDATIONS**
 - **Institute a Program that Includes a Stand-By Capability to Collect Combat Data When Conflicts Occur**

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS SURVIAC PRODUCT**
 - **Financial Benefits to DoD**
 - **Potential to Decrease Aircraft Wartime Attrition Through Application of Lessons Learned**
 - **Other Benefits to DoD**
 - **Improvement in Combat Effectiveness, Readiness, and Reduction of Casualties**
 - **Changes in DoD Operations, Plans, or Procedures as a Direct Result of Product**
 - **Wartime Tactics Changed in Response to Combat Operations Lessons Learned**

RELEVANCE TO OTHER USERS

- **DATA COLLECTION APPROACH AND METHODOLOGY APPLICABLE TO OTHER APPLICATIONS WHERE A QUICK REACTION CAPABILITY IS REQUIRED**
- **NO DIRECT APPLICABILITY OF THE CURRENT COMBAT DATA OUTSIDE THE DOD**

**EVALUATION OF CANDIDATE WARHEADS
AGAINST CHEMICAL TARGETS FOR PATRIOT PAC-3**

Prepared by

**Robert G. Mapes
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and

**Larry W. Williams, Ph.D.
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Approved for Public Release: Distribution Unlimited

[The final report for this study is Limited Distribution and/or Classified.]

CONTEXT

- **DoD S&T THRUSTS 3 AND 5: AIR SUPERIORITY AND DEFENSE
ADVANCED LAND COMBAT**

**" ... To defend deployed military forces... From... Ballistic...
Missiles... Require(s) a strong effort in missile defense..."**

- **DoD KEY TECHNOLOGIES: ENERGY CONVERSION AND STORAGE**

**Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC**

TWSTIAC-2

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TWSTIAC OBJECTIVE

- **EVALUATE THE EFFECTIVENESS OF A PATRIOT PAC-3 WARHEAD CANDIDATE AGAINST A SRBM DELIVERED CHEMICAL SUBMUNITION PAYLOAD**
- **THIS PROGRAM SUPPORTS THE DoD S&T THRUSTS ON ADVANCED LAND COMBAT AND AIR SUPERIORITY AND DEFENSE**

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-3

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TWSTIAC PRODUCT

- **TWSTIAC WAS ASKED TO PROVIDE DATA FOR A SPECIFIC WARHEAD AND SPECIAL THREAT TACTICAL MISSILE CHEMICAL PAYLOAD**
- **THE PATRIOT PROJECT OFFICE REQUIRED DEMONSTRATED WARHEAD LETHALITY DATA AGAINST TACTICAL MISSILE CHEMICAL TARGETS**
- **TWSTIAC DATA GATHERING PROGRAM CONSISTED OF 2 PARTS**
 - **A high fidelity test article development using the threat description in the TWSTIAC Data Base**
 - **An experimental program to collect, analyze, and document warhead/target interaction**

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

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TWSTIAC METHODOLOGY

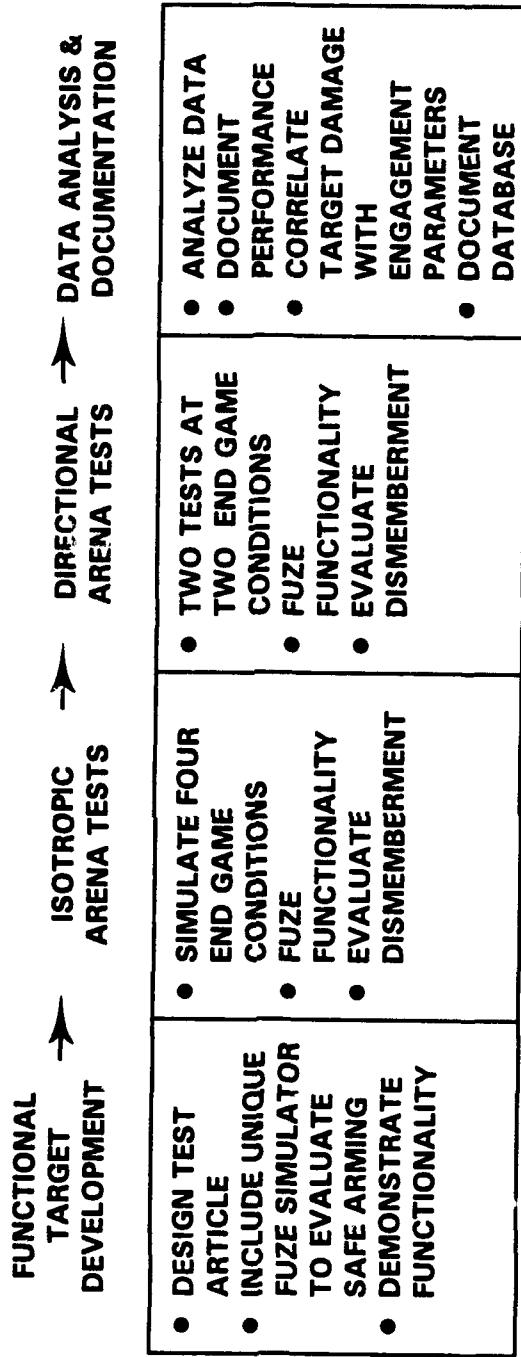
- **DEVELOP AND DEMONSTRATE A HIGH FIDELITY, FUNCTIONAL TEST ARTICLE**
- **USE THIS TEST ARTICLE IN A SERIES OF WARHEAD/TARGET ARENA TESTS TO CHARACTERIZE THE TARGET DAMAGE EFFECTIVENESS OVER A NOMINAL RANGE OF PATRIOT END GAME PARAMETERS**

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-5

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APPROACH



IAC
DATABASE
THREAT
DESCRIPTION

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

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SUMMARY OF DATA

- DATA COLLECTED

- Functional Tests

- Central burster performance
- Dispersion pattern
- Fuze arming
- Fuze dudding

- Isotropic Warhead and Directional Warhead Tests

- Structural dismemberment
- Submunitions penetrated (killed)
- Submunitions damaged
- Submunitions surviving
- Fuzes armed
- Fuzes dudded
- Central burster damage
- Target damage sensitivity to miss distance

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

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SUMMARY OF DATA

(Continued)

- **THESE STATIC TEST DATA WERE CORRELATED WITH SLED TEST
DYNAMIC DATA TO ALLOW PREDICTION OF LETHALITY UNDER
ENGAGEMENT CONDITIONS**

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

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RESULTS OF DATA ANALYSIS

- **FINDINGS**

- The evaluated warhead demonstrated the potential to increase the lethality of the Patriot PAC-3 Missile against the chemical submunition

- **TECHNICAL ADVICE/RECOMMENDATIONS**

- Recommendations for fragment pattern optimization were made
- Miss distance sensitivity was identified
- Additional kill mechanisms were validated

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

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CONSEQUENCES

- **THE FINDINGS AND DATA COLLECTED IN THESE TASKS WILL DIRECTLY SUPPORT THE DAB PROCEEDINGS**
- **INCREASED EFFECTIVENESS OF A MAJOR AIR DEFENSE SYSTEM IN THE TMD ROLE WAS DEMONSTRATED**

Prepared by: R. G. Mapes-Battelle/
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RELEVANCE TO OTHER USERS

- **THESE DATA WILL BE MADE AVAILABLE TO THE US ARMY SPACE AND STRATEGIC DEFENSE COMMAND/SURVIVABILITY LETHALITY AND KEY TECHNOLOGIES (USASDC/SLKT) LETHALITY DATA BASE AND WILL SUPPORT THE DEVELOPMENT OF LETHALITY CRITERIA FOR THEATRE HIGH ALTITUDE AREA DEFENSE SYSTEMS (THAADs), EXTENDED RANGE INTERCEPTOR (ERINT) AND CORPS SURFACE-TO-AIR-MISSILE (CORPS SAM), WHICH MUST ENGAGE THIS TARGET**
- **THE DATA WILL BE USED TO VALIDATE AN END GAME LETHALITY MODEL TO PREDICT ENGAGEMENT EFFECTIVENESS**

Prepared by: R. G. Mapes-Battelle/
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TWSTIAC-11

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**TWSTIAC CASUALTY REDUCTION MODELING
FOR THE
NATICK RD&E CENTER**

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Approved for Public Release: Distribution Unlimited

[The final report for this study is Limited Distribution and/or Classified.]

CONTEXT

- DoD S&T THRUSTS 5 AND 6: ADVANCED LAND COMBAT SYNTHETIC ENVIRONMENTS
 - To develop and field land warrior system equipment which improves warrior lethality and survivability
 - DoD S&T Thrust 5: 21st Century Land Warrior (21 CLW) Top Level Demonstration (TLD)
 - Generation II Soldier Advanced Technology Demonstration (ATD)
 - Development of casualty assessment methodologies
 - Development of warrior performance methodologies
 - Development of dismounted warrior distributed
- DoD MILITARY MISSION/FUNCTIONS: GROUND FORCES/INFANTRY SYSTEMS

Prepared by: J. A. O'Keefe-Natick/
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TWSTIAC-2

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TWSTIAC TASK/BASIC INFORMATION PRODUCT

TWSTIAC WAS ASKED TO:

- **REVIEW AND COMPARE CASUALTY REDUCTION ANALYSIS METHODOLOGIES**
- **INSTALL NEW MUNITIONS CHARACTERISTICS (ARTILLERY, MORTAR, HAND GRENADE, FLECHETTES, MINES, BOMBS, MISSILES)**
- **DETERMINE THREAT EFFECTS OF MUNITIONS**
- **ASSESS HEAT STRESS AND MOBILITY REDUCTION OF EQUIPMENT**
- **DOCUMENT CASUALTY REDUCTION METHODOLOGY**

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TWSTIAC-3

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TWSTIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Literature search**
 - **Data analysis**
 - **Data synthesis**
- **APPROACH**
 - **Provided experienced ballisticians**
 - **Created new munition tables for ballistic casualty assessment models**
 - **Developed graphic presentation routines for ballistic casualty assessment models**
 - **Developed metabolic work inputs for integrated soldier and small unit performance simulation**

Prepared by: J. A. O'Keefe-Natick/
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TWSTIAC-4

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ASSISTANCE DELIVERED

- **PRE-AND POSTPROCESSORS TO EASE INPUT AND GRAPHICALLY DISPLAY OUTPUT**
- **METHODOLOGIES REVIEWED AND DOCUMENTED**
- **NEW MUNITION CHARACTERISTICS ADDED TO INPUT DATA LIBRARIES**
- **LETHAL AREA EFFECTS ANALYZED**
- **HEAT STRESS DUE TO ADDITION OF BODY ARMOR TO MOPP IV CONFIGURATION ANALYZED**

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TWSTIAC-5

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RESULTS OF DATA ANALYSIS

- **FINDINGS RESULTING FROM THE ANALYSIS OF DATA COLLECTED BY TWSTIAC**
 - Additional research is required to correct the underlying methodologies upon which JTCGE-ME ballistic casualty assessment methodologies are based
 - Additional research is required to develop a dismounted soldier protocol data unit for DIS
- **SUMMARY OF TECHNICAL RECOMMENDATIONS**
 - Additional research to modify the existing ballistic casualty assessment methodologies to allow assessment of non-uniform ballistic protection

Prepared by: J. A. O'Keefe-Natick/
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TWSTIAC-6

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CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF TWSTIAC PRODUCTS?**
 - **Financial benefits to DoD**
 - **Automated tools to support selection of new materials for ballistic protection**
 - **Reduced cost for execution of automated tools**
 - **Other benefits to DoD**
 - **Development of ballistic casualty methodologies for incorporation in integrated soldier simulations**
 - **Development of metabolic work methodologies for inclusion in DIS Soldier System Simulations**

Prepared by: J. A. O'Keefe-Natick/
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TWSTIAC-7

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RELEVANCE TO OTHER USERS

- **RELATED OR ANALOGOUS SUBSTANTIVE PROBLEMS FOR WHICH TWSTIAC PRODUCT WOULD BE RELEVANT**
 - **Ballistic casualty assessment models are in use by AMSAA, Dismounted Warfighting Battle Laboratory, and IDA**
- **RELATED OR ANALOGOUS PROBLEMS FOR WHICH THE TWSTIAC PRODUCT WOULD BE RELEVANT BECAUSE OF THE DATA OR METHODOLOGY USED**
 - **Assessment of the combined casualty effects of chemical fragmentation munitions**
 - **Realistic casualty modeling for dismounted individuals in virtual reality and DIS simulations**

Prepared by: J. A. O'Keefe-Natick/
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TWSTIAC-8

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**TWSTIAC TECHNOLOGY ASSESSMENT PROGRAM
FOR JSSAP/SMALL ARMS MASTER PLAN (SAMP)**

Prepared by

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Approved for Public Release: Distribution Unlimited

(The final report for this study is Limited Distribution and/or Classified.)

CONTEXT

- **DoD S&T THRUST 5: ADVANCED LAND COMBAT**
- **DoD MILITARY MISSIONS/FUNCTIONS: GROUND FORCES/INFANTRY SYSTEMS**
- **TO DEVELOP AND FIELD LAND WARRIOR SYSTEM EQUIPMENT WHICH IMPROVES WARRIOR LETHALITY AND SURVIVABILITY**
 - **DoD S&T Thrust 5: 21st Century Land Warrior (21 CLW) Top Level Demonstration (TLD)**
 - **U.S. Army Small Arms Master Plan**
- **THE U.S. ARMY INFANTRY SCHOOL'S SMALL ARMS MASTER PLAN OUTLINED SMALL ARMS REQUIREMENTS FOR THE FUTURE**

Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-2

William.vu

CONTEXT (Continued)

- **THE JOINT SERVICE SMALL ARMS PROGRAM (JSSAP) OFFICE DEVELOPED A BLUEPRINT TO REACH THESE OBJECTIVES, WHICH INCLUDED:**
 - **Leap ahead technology exploration that will challenge the advancements in the area of small arms**

**Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC**

TWSTIAC-3

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TWSTIAC TASK/BASIC INFORMATION PRODUCT

- **BASELINE AND EMERGING/FUTURE TECHNOLOGIES NEEDED TO BE IDENTIFIED/EVALUATED/PRIORITIZED FOR EXPLOITATION IN FUTURE SMALL ARMS RDT&E**
- **ASSISTANCE REQUESTED BY THE JOINT SERVICE SMALL ARMS PROGRAM (JSSAP) OFFICE:**
 - **Conduct an assessment of technologies currently available or under development that could impact the performance and utility of future infantry small arms weapons systems**
 - **Perform analyses in support of four aspects of small arms development**
 - **Bursting munitions**
 - **Individual weapons**
 - **Fire control**
 - **Crew served weapons**

Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-4

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TECHNOLOGIES SOUGHT FOR THESE BENEFITS

- **IMPROVED LETHALITY**
- **GREATER LETHAL RADIUS/AREA/VOLUME**
- **EXTENDED OR MULTIPURPOSE CAPABILITIES**
- **GREATER USEFUL RANGE**
- **REDUCED ROUND SIZE/VOLUME/WEIGHT**
- **REDUCED TIME-OF-FLIGHT**
- **IMPROVED TARGET ACQUISITION**
- **IMPROVED KILL PROBABILITY**

Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-5

William.vu

TWSTIAC METHODOLOGY

- **DATA EXPLOITATION**
 - **Collection to identify ongoing work**
 - **Analysis to determine technology risk and operational payoff**
 - **Synthesis to prioritize findings**
- **APPROACH**
 - **Developed guidelines to assess technical risk as low, medium, or high for near-term, mid-term, and far-term**
 - **Used earlier technology assessments as a starting point for data collection and analysis**
 - **New data obtained from current projects and new starts**

Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-6

William.vu

SUMMARY OF DATA COLLECTED

- **ADVANCEMENTS IN MATERIALS, PROPELLANTS, EXPLOSIVES, WARHEAD CONCEPTS, WEAPONS DESIGN TECHNOLOGIES, SENSOR TECHNOLOGIES, AND IMAGING SYSTEMS**
- **MINIATURIZATION AND APPLICATION OF NEW MATERIALS WERE COMMON THROUGHOUT AND SUGGESTIONS WERE IDENTIFIED FOR LEVERAGING THESE AGAINST FUTURE SMALL ARMS DEVELOPMENTS**

**Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC**

TWSTIAC-7

William.vu

RESULTS OF DATA ANALYSIS

- PURSUIT OF ENABLING TECHNOLOGIES COULD PROVIDE SIGNIFICANT OPERATIONAL PAYOFFS, PARTICULARLY IN AREAS SUCH AS MATERIALS, CAD, LASER, COMPUTER CHIP PACKAGING, DISPLAYS, SENSORS, AND DISPLAY MINIATURIZATION
- TECHNOLOGY CONVERGENCE MAY LEAD TO A MULTIPLE-KILL-EFFECT WEAPON COMBINING THE CAPABILITIES OF A LASER, A KINETIC ENERGY-BASED RIFLE, AND A BURSTING MUNITIONS LAUNCHER
- RECOMMENDED:
 - Various technologies were recommended for R&D according to technical risk and operational payoff for the near-, mid-, and far-term

Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-8

William.vu

TECHNICAL RISK GUIDANCE

| To Full Scale Development | Low Risk | Medium Risk | High Risk |
|---------------------------|--|--|--|
| Far-Term | Technology well understood. Proof of principle demonstrated, but application concept ... | Technology new but understood. Early experiments hold some promise. Significant ... | Theory not fully understood or developed. Basic research being conducted. |
| Mid-Term | Technology established. Application concept defined and proof of principle successful ... | Technology has been partially tested. Application concept needs further definition. Manufacturing .. | Proof of principle demonstrated only in part. Application concept needs further definition ... |
| Near-Term | Technology applications exist in some systems. Component application proven, but integration ... | Proof of principle demonstrated. Engineering solutions to design and producibility ... | Proof of principle demonstrated. Concepts to apply technology defined, but not tested ... |

Prepared by: B. J. Tullington-Battelle/
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TWSTIAC-9

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CONSEQUENCES

- THIS TWSTIAC PRODUCT HAS BEEN USED TO REFINE THE SAMP BLUEPRINT AND IS NOW REFLECTED IN THE DRAFT STRATEGIC PLAN FOR DoD S&T THRUST 5--ADVANCED LAND COMBAT AS THE "OBJECTIVE INDIVIDUAL COMBAT WEAPON (OICW)":

"...the OICW is envisioned as an integrated package of leading-edge technologies emphasizing miniaturized fuzing and modular, full solution fire control; compact kinetic energy projectile, fragmenting, air bursting munition; and light-weight, high strength materials."

Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-10

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LOGISTICS

**EVALUATION OF LIGHTWEIGHT INTEGRATED SUIT
TECHNOLOGIES (LIST) AND ASSOCIATED TEST
METHODS**

Prepared by

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Chemical Biological Information Analysis Center
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2113 Emmorton Park Road
Edgewood, MD 21040**

Approved for Public Release: Distribution Unlimited

CONTEXT

- **ADVANCED LAND COMBAT (S&T THRUST)**
 - **Rapid Force Deployment**
 - **Tactical Mobility**
 - **Quick Mission Accomplishment**
 - **Minimal Casualties Against Heavy Armor and Smart Weaponry**
- **NBC ENVIRONMENT LIKELY**
 - **Proliferation**
 - **Biotechnology Advances**
 - **Affects Battlefield Dynamics**
 - **Survivability**
 - **Performance Degradation**
 - **Support**

IAC TASK

- **WHAT**
 - **Resolve Issues Resulting from the use of two Different Test Methods to Evaluate Protective Clothing**
 - **Validate without Polyethylene Film Test**
 - **Correlate with and without Film Methods**
 - **Fill Critical Gaps in Database for Current and Developing Material Technologies**
 - **Determine the Effects of Wearing Suits Upon Levels of Protection Provided**
- **WHY**
 - **Improved Protective Capabilities Needed**
 - **Reduction in Heat Stress**
 - **Reduction in Logistical Support Requirements**
 - **More Sensitive Test Method Needed**
- **WHO**
 - **U.S. Army**

IAC METHODOLOGY

- **PERFORM SIDE BY SIDE COMPARISONS OF TEST METHODS**
 - **Test Worn Suit Materials using both Methods**
- **ATTEMPT TO CORRELATE TEST RESULTS**

RESULTS

- **WORN LIGHTWEIGHT SUIT MATERIALS SHOWN TO PROVIDE ADEQUATE LEVELS OF CHEMICAL AGENT RESISTANCE**
- **DATA GENERATED USING DIFFERENT METHODS COULD NOT BE CORRELATED**
- **"RELATIVE" RANKINGS OF SUIT MATERIALS FOUND TO BE SIGNIFICANTLY DIFFERENT DEPENDING UPON METHOD USED**
- **TESTING WITHOUT FILM FOUND TO BE MORE SENSITIVE AND A BETTER METHOD FOR QUANTIFYING THE EFFECTS OF WEAR**

CONSEQUENCES

- **PROVIDED VALUABLE GUIDANCE FOR WEAR AND LOGISTICAL SUPPORT OF LIGHTWEIGHT CLOTHING DURING OPERATION DESERT STORM (ODS)**
- **WITHOUT PE FILM ADOPTED AS THE U.S. STANDARD SWATCH TEST METHOD FOR MATERIALS EVALUATION**
- **STANDARDIZED QUALITY CONTROL AND QUALITY ASSURANCE METHODS FOR EVALUATION OF CHEMICAL PROTECTIVE CLOTHING MATERIALS**
- **EVOLUTION OF JOINT SERVICES PROGRAM - JSLIST**

RELEVANCE TO OTHER USERS

- **ORGANIZATIONS RESPONSIBLE FOR ESTABLISHING STANDARDS AND TEST METHODS FOR CHEMICAL PROTECTIVE CLOTHING (CPC)**
 - **ASTM**
 - **ISO**
- **TESTERS OF CPC**
- **USERS OF CPC**
 - **Hazmat Teams**
 - **Department of Transportation (DOT)**
 - **Department of Energy (DOE)**
 - **Manufacturers of Hazardous Chemicals**



ARMY NAVY AIR FORCE NASA FAA NATO

CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER (CSERIAC) PRODUCTS & SERVICES

Presented by

**Donald Dreesbach
AL/CFH/CSERIAC**

Bldg. 248

2255 H Street

Wright-Patterson AFB, OH 45433-7022



ADVANCED HUMAN SYSTEM INTERFACE DESIGN IN CONTROL ROOMS

- **Task Overview & Project History**
- **Shortcomings of Scientific and Technical Information**
- **Subject Matter Reviewed**
- **CSERIAC's Review and Analysis Services**
- **Results of CSERIAC's Efforts**
- **Consequences of CSERIAC's Efforts**
- **Applications**



PROJECT OVERVIEW AND HISTORY

- CSERIAC and the Nuclear Regulatory Commission
 - » Human Systems Interface Design Review Guideline (NUREG/CR-5908)
- Project History
 - » Document review process



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SHORTCOMINGS OF SCIENTIFIC AND TECHNICAL INFORMATION

- Shortcomings of Scientific and Technical Information,
Control Rooms Revisited:
 - » Changing technology
 - » Research gaps
 - » Advances in human factors research



SUBJECT MATTER REVIEWED BY CSERIAC

- **Human factors and control room design**
 - » **Display and Control Technologies**
 - » **Automation, Intelligent Aids, and Human Error**
 - » **Nuclear Power Plant Control Room Integration**



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CSERIAC REVIEW & ANALYSIS SERVICES

- Purpose
- Procedure
- Content
- Synthesis



RESULTS OF CSERIAC's EFFORTS

- **Reviews & Analyses Final Reports:**
 - » Display and Control Technologies
 - » Automation, Intelligent Aids, and Human Error
 - » Nuclear Power Plant Control Room Integration



CONSEQUENCES OF CSERIAC's EFFORTS

- Project Evaluation
- Further Study
- Update:
 - » Advanced Human Systems Interface Design Review Guideline
 - » The design of future control facilities





APPLICATIONS

- **Benefits to the design of control facilities:**
 - » Extensive review of display control technologies
 - » Expanding upon research and applications of human factors in automation
 - » Expanding upon research and applications of artificial intelligence
 - » Expanding upon research in the area of human error
 - » Expanding upon research in the area of system integration



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INTEGRATED MAINTENANCE INFORMATION SYSTEM (IMIS): DEFINED

- Human Factors issues in the design of the IMIS -
Portable Maintenance Aid
 - IMIS is the maintenance technician's interface with:
 - » Maintenance Information Workstations
 - CAMS (Maintenance Records)
 - SBSS (Supply)
 - CEMS (Engine Monitoring)
 - » Aircraft interface panels



IMPROVED TACTICAL AIRCRAFT MAINTENANCE THROUGH HUMAN FACTORS: IMIS BENEFITS

- **IMIS will improve tactical aircraft maintenance by:**
 - Reducing maintenance downtime
 - Preventing false removals of system components
 - Increasing the productivity of inexperienced technicians
 - Providing more accurate and complete maintenance data



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TECHNICAL INFORMATION AT THE TECHNICIAN'S FINGERTIPS: IMIS COMPONENTS

- CSERIAC supported the collection, review, and analysis of human factors technical information for the design of hand-held computers in maintenance environments.
- IMIS provides centralization for maintenance information including:
 - » Technical Orders
 - » Supply and Management Data
 - » Training Data
 - » Aircraft Maintenance Records
 - » Flight Data
 - » Aircraft Diagnostics



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HUMAN COMPUTER INTERACTION ON THE FLIGHTLINE: IMIS GOALS

- **Improved maintenance performance**
- **Develop new concepts and technologies**
 - » Develop new ideas for improving maintenance
 - » Test ideas with few dollars before commitment
 - » Develop enabling technologies
- **Focus on the End-User**
 - » Develop systems from technician's point of view
 - » Conduct field evaluations with maintenance technicians
- **Transition results to system implementors**
 - » Weapon system SPOs (F-22, F-16, JSTARS, C-17, B-2)
 - » Computer-aided acquisition and logistics support (CALS)



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RESULTS OF CSERIAC's EFFORTS

- **Specification for IMIS interface**
 - **Common user interface specification**
 - » Reviewed of Human System Interface issues
 - » Recommended design constraints of the portable maintenance aid
 - **Technical information presentation specification**
 - » MIL-M-87268 general content, style, format, user interaction requirements
 - » Identified user-centered information needs
 - **Lessons Learned as they apply to DoD programs**



CONSEQUENCES OF CSERIAC's EFFORTS

- CSERIAC's information support permitted timely and accurate:
 - » Specification of:
 - User interface needs
 - IMIS hardware
 - Information content of maintenance tasks
 - Access structures
 - Style and format of information
 - » Identification of:
 - Alternative technologies
 - Human System Interface analysis of requirements for maintenance applications
 - » Development of:
 - Specification/manual
 - Lessons learned document



IMIS APPLICATIONS

- **IMIS will be applied to the maintenance of:**
 - F-22
 - F-16
 - B-2
 - JSTARS
 - Army M-1

- **Technology transfer**



CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER (CSERIAC) PRODUCTS & SERVICES

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HUMAN FACTORS IN THE DESIGN OF SYNTHETIC ENVIRONMENTS

- **Task Overview**
- **Project Scope**
- **Subject Matter Addressed**
- **CSERIAC Search & Summary Services**
- **Results of CSERIAC's Efforts**
- **Consequences of CSERIAC's Efforts**
- **Applications**



HUMAN FACTORS IN THE DESIGN OF SYNTHETIC ENVIRONMENTS

- **Definition**
- **Benefits**
- **Components**
- **Goals**
- **Results of CSERIAC's Efforts**
- **Consequences of CSERIAC's Efforts**
- **Applications**



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HUMAN FACTORS IN THE DESIGN OF SYNTHETIC ENVIRONMENTS: TASK OVERVIEW

- **CSERIAC support of the Small Business Innovative Research
Program**
 - » Intelligent Information Presentation for Helmet Mounted Displays in
Synthetic Environments
 - » Force Tactile Feedback for Virtual Reality Environments
 - » Interaction with 3-D "Virtual" Environments



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STATE-OF-THE-ART HUMAN FACTORS TECHNICAL INFORMATION: PROJECT SCOPE

- **Exploration of literature to support research for innovative concepts to solve defense-related scientific or engineering problems.**
 - » **Explore the presentation of tactical information**
 - » **Review how humans use tactile feedback in manipulating controls and displays**
 - » **Investigate how humans interact with 3-D virtual environments**



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SUPPORTING INNOVATIVE RESEARCH: SUBJECT MATTER ADDRESSED

- **CSERIAC identified:**
 - Research on the presentation of information for Helmet Mounted Displays
 - » Pilot information load
 - » Information usage
 - » Hardware constraints
 - Literature on force tactile feedback
 - Information for the creation of natural and realistic environments.



CSERIAC SEARCH & SUMMARY SERVICES

- Definition
- Procedure
- Purpose
- Scope



RESULTS OF CSERIAC's EFFORTS

- Intelligent Information Presentation for Helmet Mounted Displays in Synthetic Environments**
- Force Tactile Feedback for Virtual Reality Environments**
- Interaction with 3-D "Virtual" Environments**





CONSEQUENCES OF CSERIAC's EFFORTS

- CSERIAC provided a firm basis so small businesses could meet the research needs of the Department of Defense.



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APPLICATIONS

- There are few limitations to the scope of CSERIAC's Research. Although the information is intended for use in aviation settings, the results can be applied to most research and development for synthetic environments.

**DATA & ANALYSIS CENTER
FOR SOFTWARE (DACs)**

**OPEN ARCHITECTURE SYSTEMS FOR
PROCESS AUTOMATION (OASYS)**

Prepared by

**James J. Reed
Data & Analysis Center for Software
Kaman Sciences Corporation
258 Genesee St., Suite 103
Utica, NY 13502**

Approved for Public Release: Distribution Unlimited

OPEN ARCHITECTURE SYSTEMS FOR PROCESS AUTOMATION (OASYS) TOOLSET

- **THE OASYS TOOLSET FOR PROCESS AUTOMATION IS A SUITE OF SOFTWARE TOOLS USED FOR THE RAPID PROTOTYPING AND LOW-COST MAINTENANCE OF WORKFLOW PROCESS SYSTEMS.**

- **DoD Key Technologies: Computer Software / Computers**
 - o **Software and Systems Engineering**
 - o **Human - Computer Interface**
 - o **Software for Parallel & Heterogeneous Distributed Systems**
- **DoD Science & Technology Thrust - 7**
 - o **Technology for Affordability**
- **DoD Military Missions/Functions**
 - o **Technology Transfer**

DACS - 2

Prepared by: James J. Reed

OASYS TOOLSET PROJECT INFORMATION

- **DEVELOPED TO AUTOMATE PRODUCTION OF TECHNICAL DATA PACKAGES FOR WEAPON SYSTEM PROCUREMENT**
- **WORK PACKAGE TRACKING THROUGH DOCUMENT SYSTEMS**
- **MULTI-USER, DISTRIBUTED, HETEROGENEOUS SYSTEMS**
- **OPEN SYSTEM ENVIRONMENT OPERATIONS**
- **ROUTING, PROCESSING & TRACKING OF FORMS & IMAGES**
- **REPLACEMENT FOR HIGH MAINTENANCE SYSTEMS**

- **SPONSOR: US ARMY ARDEC**
PICCATINNY ARSENAL, NJ
AND
USAF ROME LABORATORY
Griffiss AFB, NY 13441

DACS - 3

Prepared by: James J. Reed

OASYS TOOLSET DEVELOPMENT METHODS

- **OASYS TOOLSET METHODOLOGY EMPLOYED**

- **COTS RDBMS And 4GL Application Manager**
- **Object Oriented Design**
- **Client/Server Architecture**

- **PROCESS AUTOMATION APPROACH**

- **Open Systems Environment**
- **Requirements Engineering**
- **Rapid Prototyping**
- **User Training**
- **User Maintained**

DACS - 4

Prepared by: James J. Reed

PROCESS AUTOMATION SYSTEM FEATURES

- **FULL AUDITING OF WORK PACKAGE ACTIONS**
- **FLEXIBLE ROUTING OF FIXED & AD HOC OPTIONS**
- **ELECTRONIC SIGNATURES WITH MULTIPLE SECURITY**
- **FORMS ON PLAIN WHITE BOND WITH SCRIPT SIGNATURES**
- **IMPORT/EXPORT DATA FROM OTHER PLATFORMS**
- **‘BUBBLE-UP’ MANAGEMENT & EMAIL**
- **PROBLEMS & RESOLUTIONS**
- **PAPERLESS SYSTEM**

DACS - 5

Prepared by: James J. Reed

OASYS TOOLSET RESULTS IN TDP TRACKER

- **TDP TRACKER GOALS**
 - **Link Multiple Users in Distributed System**
 - **Reduce TDP Processing Time From Over 190 to Less Than 60 Days**
 - **Reduce Cost/Improve Quality**
 - **Reduce Paper Volume**
 - **Reduce System Maintenance**
- **TDP TRACKER RESULTS**
 - **> 700 Users at Dover, NJ, Rock Island, IL, and Aberdeen, MD**
 - **Processing Time < 28 Days**
 - **Cost Savings of > \$400,000.00 Per Day**
 - **All Electronic System**
 - **Maintained By One Government Employee**

DACS - 6

Prepared by: James J. Reed

ADDITIONAL APPLICATIONS

- **USA WATERVLIET ARSENAL - ACQUISITION SYSTEM**
- **DTIC - IAC PROGRAM TECHNICAL AREA TASK TRACKER**
- **USA LIFE CYCLE SOFTWARE ENGINEERING CENTER
UPGRADE 10 YEAR OLD ACQUISITION SYSTEM**
- **KAMAN AND OTHER CORPORATE CUSTOMERS IN
MANUFACTURING / PRODUCTION ENVIRONMENTS**
- **ANY GOVERNMENT OR COMMERCIAL PROCESS
AUTOMATION SYSTEM REQUIRING DOCUMENT/DATA
MANAGEMENT**

DACS - 7

Prepared by: James J. Reed

**ACADEMIC APPAREL RESEARCH
TECHNICAL SUPPORT AND PRODUCTS FOR DLA**

Prepared by

**Michal Safar
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Chicago, IL 60616**

Approved for Public Release: Distribution Unlimited

ACADEMIC APPAREL RESEARCH DOD MISSION - LOGISTICS

- **DEFENSE LOGISTICS AGENCY CONTEXT**
- **Maintain the Domestic Apparel Production Base**
 - Shrinking Defense Industrial Base
 - Increased dependence on foreign suppliers
 - Dwindling surge potential
- **Develop and Maintain Surge Capability for Apparel (Military Uniforms)**
 - Develop production technologies
 - Leveraging commercial technologies
 - Modernization Issues

ACADEMIC APPAREL RESEARCH DOD MISSION - LOGISTICS

- **DLA TASK COMPONENTS**
 - **Overview DLA Military Sewn Products Automation**
 - o **Demonstration sites**
 - o **Research projects**
 - o **Academic based research**
 - **Provide Technical Research for MILSPA**
 - **Provide a Forum for Presentations of Apparel Research**
 - o **DLA Researchers**
 - o **Other academic researchers**
 - o **Special research topics**
 - o **Demonstrated Industry applications**
 - **Summarize Technical Results in Proceedings and Reports**

ACADEMIC APPAREL RESEARCH DOD MISSION - LOGISTICS

- **DLA TASK METHODOLOGY**
 - **Apparel Manufacture Data Collection, Analysis and Synthesis**
 - **Conference Technical Program Coordination**
 - **Conference Proceedings and Other Reports**
- **DLA TASK APPROACH**
 - **Partnership Approach**
 - **DLA - MTIAC - Researchers**
 - **Understand the common goals**
 - **Develop communication and coordination**

ACADEMIC APPAREL RESEARCH DOD MISSION - LOGISTICS

- **DLA APPAREL MANUFACTURE DATA**
 - **Apparel Manufacture Worldwide Research**
 - o **Foundation for AMIS data base**
 - **Apparel Manufacturing Technology**
 - **Technical Papers**
- **RESEARCH THEMES**
 - **Apparel Manufacture Automation**
 - **Software for Apparel Manufacture**

ACADEMIC APPAREL RESEARCH DOD MISSION - LOGISTICS

- **TECHNICAL RESEARCH NEEDS IDENTIFIED**

- **Domestic Capability**
- **Equipment and Process Automation**
- **Cooperative Research**

- **TECHNICAL AREA FOCUS**

- **CIM**
- **Production Methods**
- **Ergonomics**
- **Apparel Products**
- **Quality**

ACADEMIC APPAREL RESEARCH DOD MISSION - LOGISTICS

- **TECHNICAL RESEARCH DIRECTIONS**
 - **Apparel Research Network**
 - **Customer Driven Uniform Manufacture**
 - **Demonstration Sites**
- **OTHER BENEFITS**
 - **Technical Program Partnership**
 - **Improved Manufacturing Techniques for Apparel Industrial Base**

ACADEMIC APPAREL RESEARCH DOD MISSION - LOGISTICS

- **RELEVANCE TO TECHNICAL ISSUES**
 - **Industrial Surge Capability**
 - **Commercial Apparel Industry**
 - **Machine Tool Industry**
- **OTHER BENEFITS**
 - **Technical Conference Support**
 - **Methodology - IAC as Research Partner**

NTIAC

**QUANTITATIVE NONDESTRUCTIVE
EVALUATION (NDE) DATA BOOK**

Presented by

George A. Matzkanin

NTIAC

Texas Research Institute Austin, Inc.

Austin, Tx. 78746

Approved for Public Release; Distribution Unlimited

Prepared by: George A. Matzkanin

NTIAC - 1

CONTEXT

- THIS TASK ADDRESSES THE FOLLOWING DEFENSE SCIENCE AND TECHNOLOGY STRATEGY ELEMENTS:
 - S & T Thrust 7, Technology for Affordability
 - Task goals: Reduce life-cycle costs; improve work flow scheduling; optimize system performance
 - Key Technology 10, Design Automation
 - Task goals: Enhance effectiveness of systems design; provide a quantitative basis for computer-aided design

OBJECTIVES

- **FOCUS OF NTIAC TASK**
 - Consolidate NDE engineering, inspection reliability, and application data into a single source, in a uniform format, to provide an engineering reference for design, maintenance, life-cycle management, and life extension
- **RELATIONSHIP TO DEFENSE S & T STRATEGY**
 - Reduce life cycle costs to achieve significant performance and affordability improvements
 - Reduce product development time by providing a quantitative basis for computer-aided design

METHODOLOGY

- COLLECT, ORGANIZE, ANALYZE, AND CATALOG DATA GENERATED AND DOCUMENTED IN VARIOUS FORMS FOR A NUMBER OF GOVERNMENT AGENCIES
- ORGANIZE NDE ENGINEERING DATA TO PROVIDE RAPID ACCESS OF SALIENT INFORMATION TO A VARIETY OF POTENTIAL USERS
- PHASE I PROVIDES AN INTRODUCTION AND BASELINE REFERENCE FOR COMMON ENGINEERING MATERIAL, SIMPLE SHAPES, AND GENERAL INDUSTRY ENVIRONMENTAL CONDITIONS

Prepared by: George A. Matzkanin

NTIAC - 4

SUMMARY OF DATA

- **INFORMATION COLLECTED FROM EXISTING AIR FORCE AND NASA ENGINE COMPONENT INSPECTION DATA**
- **DATA PROCESSED ELECTRONICALLY AND PRESENTED IN BOTH GRAPHICAL AND TABULAR FORM USING ESTABLISHED ANALYTICAL METHODS**
- **DATA ACQUIRED FROM APPROXIMATELY 15,000 MEASUREMENTS/OBSERVATIONS FROM LIQUID PENETRANT, ULTRASONIC, X-RADIOGRAPHY, EDDY CURRENT, AND MAGNETIC PARTICLE NDE METHODS**

RESULTS

- ESTABLISH STANDARD PROCEDURES FOR DETERMINING THE PROBABILITY OF DETECTING FLAWS OF VARIOUS SIZES IN COMPONENTS
- CATALOG PROBABILITY OF DETECTION (POD) CURVES FOR ASSESSING THE CAPABILITY OF NDE MEASUREMENT PROCEDURES
- PROVIDE A QUANTITATIVE BASIS FOR VALIDATING AND COMPARING NDE PROCEDURES

Prepared by: George A. Matzkanin

NTIAC - 6

CONSEQUENCES/BENEFITS

- **IMPROVED LIFE-CYCLE MANAGEMENT**
- **ESTABLISH A QUANTITATIVE BASIS FOR RETIREMENT FOR CAUSE**
- **ENHANCE SYSTEM RELIABILITY**
- **REDUCE DESIGN AND PRODUCTION COSTS**
- **SAVE ON MAINTENANCE COST**
- **REDUCE SYSTEM ACQUISITION TIME**

RELEVANCE TO OTHER USERS

- LIFE EXTENSION OF AGING SYSTEMS
 - NASA
 - Air Force
 - Federal Aviation Administration
 - Federal Highway Administration
- QUANTIFY PROFICIENCY OF INSPECTORS

RELIABLE APPLICATION OF COMPONENTS SERIES

**(DoD KEY TECHNOLOGY: SENSORS AND
ELECTRONIC DEVICES)**

Prepared By

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Rome, NY 13440-6916**

Approved for Public Release: Distribution Unlimited

RAC PRODUCT STRATEGY

- **TARGET MANAGERS**

- Awareness
- Impact on programs
- Basics
 - o Terminology
 - o Tasks
 - o Subtasks
- .
- .
- .

- **TARGET DESIGNERS**

- Impact of new technologies
- Design practices/guidelines
- Ability to trade-off alternatives

- **TARGET R/M/Q PRACTITIONERS**

- Procedural guides
- Data to support analyses
- Quick guides/automated tools

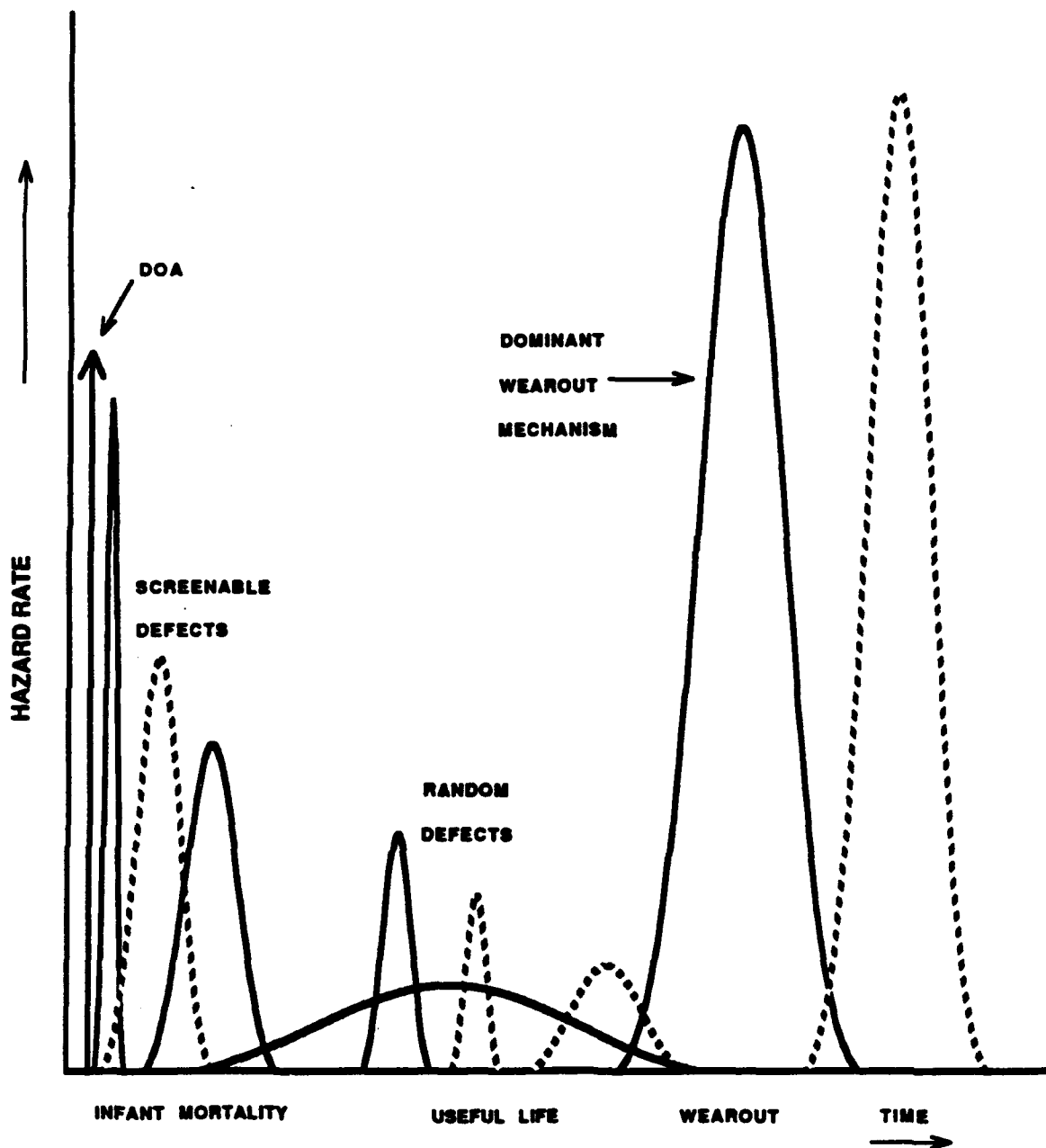
PRODUCT RELEVANCE

- **DOD KEY TECHNOLOGY: SENSORS AND ELECTRONIC DEVICES**
- **PRODUCT FOCUS**
 - **Selection and control of components**
 - **Reliability considerations/limitations**
 - o **Environments**
 - o **Screening**
 - **Failure rates/mechanisms**
 - **Replace MIL-HDBK-338 "Electronic Reliability Design Handbook" (Volume II)**
- **PRODUCT IMPACT**
 - **Help use of state-of-the-art components without sacrificing reliability**

RELIABLE APPLICATIONS OF CAPACITORS

- **APPLICATION INFORMATION**
 - **Environmental Considerations**
 - **Temperature Effects**
 - **Radiation Effects**
 - **Humidity**
 - **Shock/Vibration**
 - **Altitude**
 - **Electrical Considerations**
 - **Tolerance**
 - **Thermal Dissipation**
 - **Frequency**
 - **ESR**
 - **IR**
 - **DC Leakage**
 - **AC Leakage**
 - **Dielectric Absorption**
- **RELIABILITY DATA**
 - **Failure Rates**
 - **Life**
 - **Drift Characteristics**
- **FAILURE MODES**
- **SUMMARY OF RELIABILITY PROBLEMS**
- **DESIGN CONSIDERATIONS**
- **INFORMATION SOURCES**
- **DEFINITIONS**
- **INDEX (Subject)**

TYPICAL FAILURE MECHANISM MODEL



CURRENT RAC PRODUCTS

DATA PUBLICATIONS **6**

APPLICATION GUIDES **11**

COMPONENT PUBLICATIONS **7**

SPECIALIZED SERIES:

-- **Concurrent Engineering** **5**

-- **Reliable Applications of Components** **3 ***

-- **Total Quality Management Series** **3**

SOFTWARE/DATABASES **7**

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FAILURE MODE/MECHANISM DISTRIBUTIONS

**(DoD MISSION/FUNCTION: MAINTENANCE,
READINESS AND LOGISTICS)**

Prepared By

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RAC PRODUCT STRATEGY

- **TARGET MANAGERS**

- **Awareness**
- **Impact on programs**
- **Basics**
 - o **Terminology**
 - o **Tasks**
 - o **Subtasks**
- .
- .
- .

- **TARGET DESIGNERS**

- **Impact of new technologies**
- **Design practices/guidelines**
- **Ability to trade-off alternatives**

- **TARGET R/M/Q PRACTITIONERS**

- **Procedural guides**
- **Data to support analyses**
- **Quick guides/automated tools**

PRODUCT RELEVANCE

- **DOD MISSION/FUNCTION: MAINTENANCE, READINESS AND LOGISTICS**
- **PRODUCT FOCUS**
 - **How components fail**
 - **Frequencies of different modes/mechanisms**
- **PRODUCT IMPACT**
 - **Enables evaluation of failure consequences**
 - o **Availability**
 - o **Maintenance**
 - o **Safety**

| PART DESC. | FAILURE MODE/MECH | NORM DIST. |
|-----------------------|------------------------------|-----------------------|
|-----------------------|------------------------------|-----------------------|

Resistor, Fixed (Summary)

| | |
|-----------------------------|--------------|
| Opened | 51.0% |
| Drift | 29.1% |
| Change in Resistance | 7.0% |
| Broken | 5.4% |
| Shorted | 4.0% |
| Mechanical Failure | 3.5% |

| PART DESC. | FAILURE MODE/MECH | NORM DIST. | FAIL DIST. | DATA SOURCE(S)/DETAILS |
|---------------|----------------------|---------------|---------------|---------------------------|
|---------------|----------------------|---------------|---------------|---------------------------|

| | | | | |
|-------------------------------------|--|--|--|--|
| Resistor,Fixed,Wire Wound,Precision | | | | |
|-------------------------------------|--|--|--|--|

| | | | | |
|------------|--|--|--|--|
| Sources: 3 | | | | |
|------------|--|--|--|--|

| | | | | |
|--------|-------|-------|--|--|
| Opened | 50.5% | 50.5% | | Open-Bad Welds (25016-000, NR) High Z (24991-000, 71.0%) Open (24994-000, 30.0%) |
|--------|-------|-------|--|--|

| | | | | |
|-------|-------|-------|--|--------------------------|
| Drift | 32.5% | 32.5% | | Drift (24994-000, 65.0%) |
|-------|-------|-------|--|--------------------------|

| | | | | |
|---------|-------|-------|--|---|
| Shorted | 17.0% | 17.0% | | Low Z (24991-000, 29.0%) Short (24994-000, 5.0%) |
|---------|-------|-------|--|---|

| | | | | |
|-------|-----|------|--|--|
| Other | --- | 0.0% | | |
|-------|-----|------|--|--|

| | | | | |
|-------------------------|--|--|--|--|
| Change in Resistance | | | | |
|-------------------------|--|--|--|--|

| | | | | |
|--|--|--|----|--|
| | | | NR | |
|--|--|--|----|--|

| | | | | |
|--|--|--|--|---|
| | | | | Change in Resistance-Unstable Wire (25016-000, NR), Change in Resistance-Poor Processing (25016-000, NR), Change in Resist-Partial Short From Bad Wire Insul (25016-000, NR) |
|--|--|--|--|---|

CURRENT RAC PRODUCTS

| | |
|---|-----------------|
| DATA PUBLICATIONS | 6 * |
| APPLICATION GUIDES | 11 |
| COMPONENT PUBLICATIONS | 7 |
| SPECIALIZED SERIES: | |
| -- Concurrent Engineering | 5 |
| -- Reliable Applications of Components | 3 |
| -- Total Quality Management Series | 3 |
| SOFTWARE/DATABASES | <u>7</u> |
| | 42 |

TIME STRESS MEASUREMENT DEVICE (TSMD)

**(DoD KEY TECHNOLOGY: SENSORS AND
ELECTRONIC DEVICES)**

Prepared By

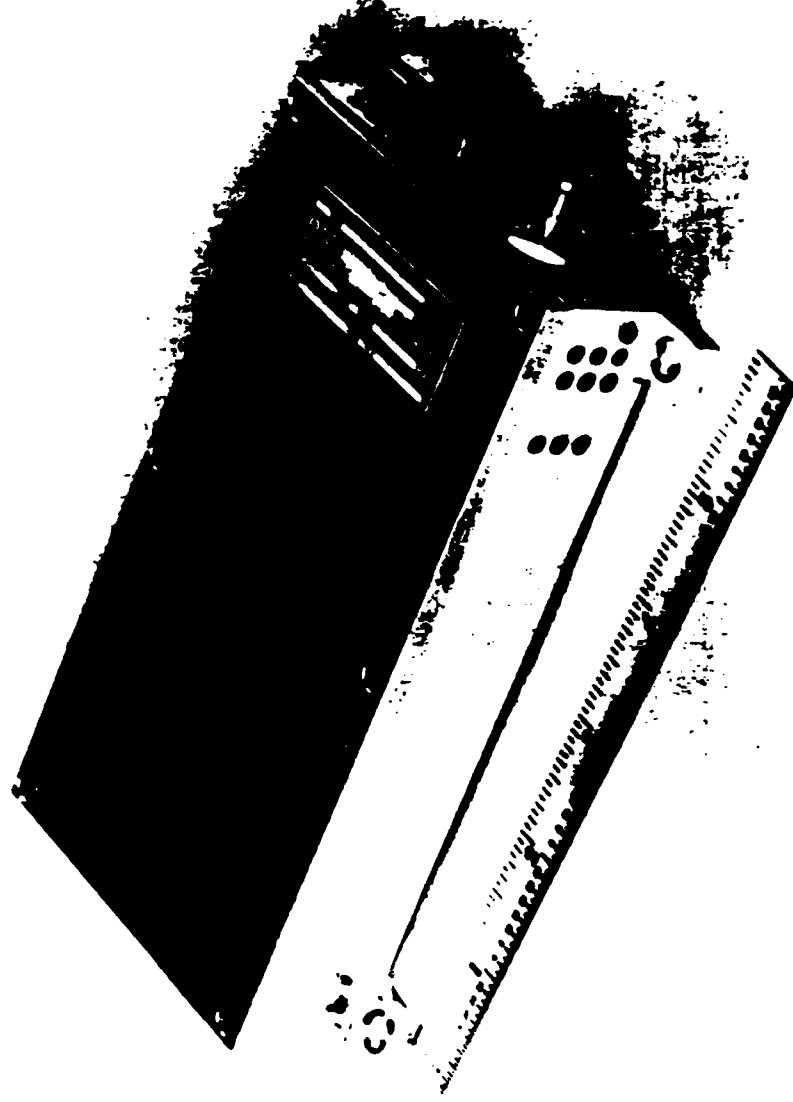
**Preston R. MacDiarmid
Director
Reliability Analysis Center
201 Mill Street
Rome, NY 13440-6916**

Approved for Public Release: Distribution Unlimited

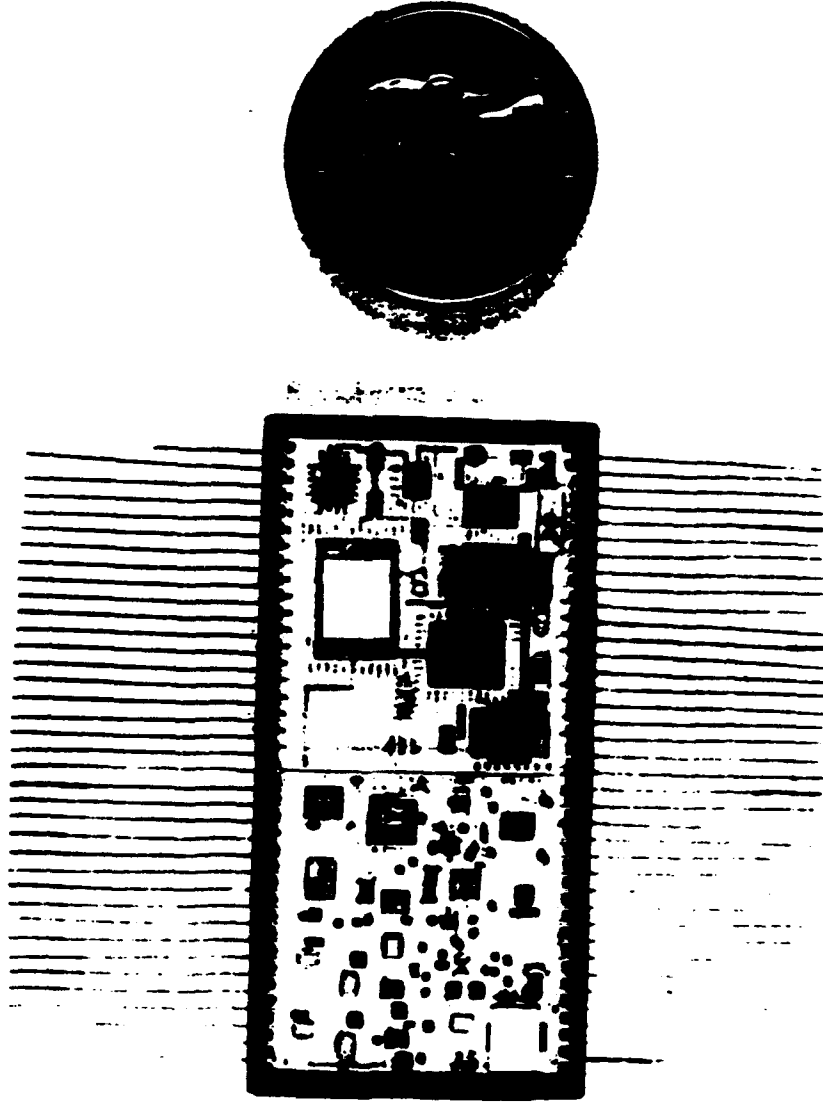
CAPABILITY RELEVANCE

- **DOD KEY TECHNOLOGY: SENSORS AND ELECTRONIC DEVICES**
- **CAPABILITY RELEVANCE**
 - **Electronic device improvements make environmental characterization cost effective**
- **CAPABILITY IMPACT**
 - **More reliable system by**
 - o **Effective characterization of design environments**
 - o **Identification of environmental stresses causing field problems**

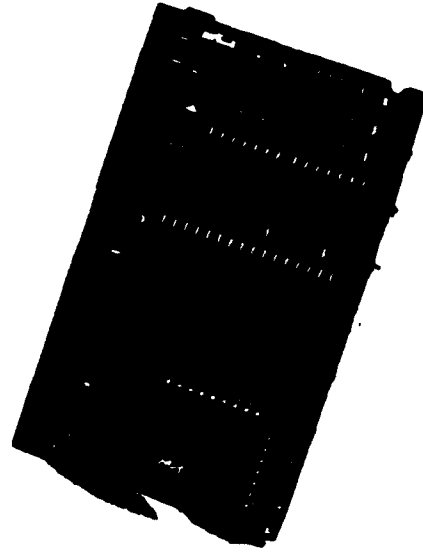
TSMD MODULE



MICRO TSMD



COMMERCIAL TSMD DEVICE



**ENVIRONMENTAL MEASUREMENT DEVICE
(As of Jun 8 1993)**

| | | |
|-----------------------|--|-------------|
| MANUFACTURER: | Onset Computer Corp. | (RAC ID 33) |
| MODEL NUMBER: | | |
| MODEL NAME: | Hobo-Temp | |
| COST: | \$99.0 - \$167.0 | |
| TYPE: | ALONE | |
| SIZE: (L-W-H): | 2.0 - 1.0 - 1.0 Inches | |
| WEIGHT: | oz | |
| POWER REQ: | One-cell battery | |
| POWER LIFE: | Up to 4 years | |
| NO. READINGS: | 1800 | |
| SAMPLE RATES: | MIN. 0.0000580 MAX. 2.00000000 (In cy/sec) | |
| MEMORY: | Non-volatile EEPROM | |
| NO. I/O LINES: | DIGITAL I/O: 0/1 ANALOG I/O: 1/0 | |
| INTERFACES: | RS232 serial Interface | |
| EVENT TAGGING: | Time stamp Date stamp | |
| SENSORS: | Internal Temperature | |

MFR. SUGGESTED APPLICATIONS:

RAC TSMD ACTIVITIES

- **RAC PUBLICATION: ENVIRONMENTAL CHARACTERIZATION
DEVICE DATABOOK**
 - **Identifies available device technology**
 - o **Measurement**
 - o **Recording**
 - o **Parameters, limits, etc.**
- **RAC SERVICE: SELECT/APPLY TECHNOLOGY FOR SPECIFIC
PROGRAM**
- **RAC DATABASES: RETAIN DATA COLLECTED TO PREVENT
DUPLICATION**



TOTAL QUALITY MANAGEMENT (TQM) TOOLKIT

(DoD S&T THRUST: TECHNOLOGY FOR AFFORDABILITY)

Prepared By

**Preston R. MacDiarmid
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Rome, NY 13440-6916**

Approved for Public Release: Distribution Unlimited

RAC PRODUCT STRATEGY

- **TARGET MANAGERS**
 - **Awareness**
 - **Impact on programs**
 - **Basics**
 - o **Terminology**
 - o **Tasks**
 - o **Subtasks**
 - .
 - .
 - .
- **TARGET DESIGNERS**
 - **Impact of new technologies**
 - **Design practices/guidelines**
 - **Ability to trade-off alternatives**
- **TARGET R/M/Q PRACTITIONERS**
 - **Procedural guides**
 - **Data to support analyses**
 - **Quick guides/automated tools**

PRODUCT RELEVANCE

- **DOD S&T THRUST: TECHNOLOGY FOR AFFORDABILITY**

- **PRODUCT FOCUS**

- Continuous improvement
- Variability reduction

- **PRODUCT IMPACT**

- Higher quality
- Reduced cost

Ordering No: SDAS-4

State-of-the-Art Report Process Action Team Handbook

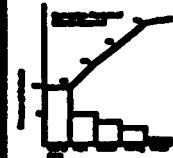
Prepared by
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Under contract to
Rome Laboratory
Gotham AFB, NY 13442-6700

Total Quality Management Toolkit

An encyclopedic
Listing of
TQM Tools

RAC
Reliability Analysis Center
PO Box 6700
Rome, NY 13442-6700



SDAS is a DoD Information Analysis Center sponsored by the
Defense Technical Information Center

State-of-the-Art Report

A GUIDE FOR IMPLEMENTING TOTAL QUALITY MANAGEMENT

RAC

Reliability Analysis Center
A DoD Information Analysis Center

TQM TOOLKIT TOPICS

| SEVEN BASIC TOOLS | SEVEN MANAGEMENT TOOLS | OTHER TOOLS |
|--|---|---|
| <p>Flow Charts</p> <p>Ishikawa Diagrams</p> <p>Checklists</p> <p>Pareto Charts</p> <p>Histograms</p> <p>Scattergrams</p> <p>Control Charts</p> | <p>The Affinity Diagram</p> <p>The Relations Diagram</p> <p>The Tree Diagram</p> <p>Matrix Analysis</p> <p>QFD</p> <p>Process Decision Program Chart</p> <p>The Arrow Diagram</p> | <p>The Force Field</p> <p>The Measles Chart</p> <p>Benchmarking</p> <p>Cycle Time Management</p> <p>Multi-Var Charts</p> <p>The Five-Why's</p> <p>Design of Experiments</p> <p>Action Plans</p> |

CURRENT RAC PRODUCTS

DATA PUBLICATIONS 6

APPLICATION GUIDES 11

COMPONENT PUBLICATIONS 7

SPECIALIZED SERIES:

-- **Concurrent Engineering** 5

-- **Reliable Applications of Components** 3

-- **Total Quality Management Series** 3 *

SOFTWARE/DATABASES 7

42

**COMPUTER-BASED AIRCRAFT WIRING
MAINTENANCE AID**

Prepared by

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Wright Patterson AFB, OH 45433-7542**

Approved for Public Release: Distribution Unlimited

CONTEXT

- **APPLY KEY DOD COMPUTER AND SOFTWARE TECHNOLOGIES TO SUPPORT AIR FORCE TACTICAL LAND-BASED FORCES FOR AIR SUPERIORITY AND PRECISION STRIKE:**
 - **To Develop Computer-Based Wiring Damage Assessor's Aid that Would Allow Maintenance Technicians Capability to Rapidly Access Wiring Data**
 - **To be Compatible with DoD Integrated Maintenance Information System (IMIS) Program**
 - **To Keep Data Current for Fielded System**
 - **To Investigate Feasibility of Using Wiring Data in Conjunction with Aircraft Self-Diagnostic Capability**

COMPUTER-BASED AIRCRAFT WIRING MAINTENANCE AID

- **KEY TECHNOLOGY**
 - **Computers, Software**
- **SURVIAC TASK FOCUS**
 - **Support the Air Force Aircraft Battle Damage Repair (ABDR) Advanced Development Technology Program (ADTP) Office**
 - **Develop/Enhance a Computerized Aircraft Maintenance Aid for Assessing Wiring Damage to Aircraft**
 - **High Performance Computing System Providing Improvements in Maintenance Capabilities**
 - **Assist in the Development of Graphics Capability and Support for Deployment for Desert Shield**

SURVIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Conduct Feasibility Study**
 - **Develop Prototype**
 - **Field-Test Prototype**
 - **Enhance Prototype Based on User Comments**
 - **Transition to Field**
- **APPROACH**
 - **Utilized Off-The-Shelf Computer Hardware/Software**
 - **Used Existing Manufacturer Wiring Data**
 - **Developed Data on Pass-Through Wires and Access Door Location**

SUMMARY OF DATA

- **DATA COLLECTED**
 - **Obtained Detailed Wiring Routing and Characteristics Data**
 - **Obtained Installation Drawings for the Specific Aircraft**
 - **Collected Numerous Suggestions from Operators on How to Improve/Enhance Prototype**
- **DATA CHARACTERISTICS**
 - **Database is Transparent to the User**
 - **User Interface Allows Quick Retrieval and Display of the Data**
 - **No Special Training Necessary; User Interface Leads the User Step by Step**

RESULTS OF DATA ANALYSIS

- **FINDINGS SYNTHESIZED BY SURVIAC**
 - **Computerized Wiring Maintenance Aid is Feasible**
 - **Field-Testing of Prototype Demonstrated that Such a Tool can Reduce Time to Repair Aircraft Wiring**
 - **Computerized Tool can be Utilized by Individuals Who have not had Electrical Training**
- **SUMMARY OF TECHNICAL RECOMMENDATIONS**
 - **Automate Aircraft Wiring Data for Expeditionary Repair of Damaged Wiring**
 - **Explore Transfer of Concept to Other DoD Aircraft, Commercial Aircraft, and Other Vehicles**

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS SURVIAC PRODUCT**
 - **Financial Benefits to DoD**
 - Reduced Time for Aircraft Wiring Repair, Hence Financial Savings
 - Less Experienced Individuals Perform at Higher Levels of Expertise
 - **Other Benefits to DoD**
 - Reduced Time to Repair Battle Damaged Aircraft Results in Improved Combat Effectiveness
 - **Changes in DoD Operations, Plans, or Procedures as a Direct Result of Product**
 - Wiring Maintenance Procedures will be Improved

RELEVANCE TO OTHER USERS

- **OTHER AIRCRAFT SYSTEMS**
 - **Hydraulics**
 - **Fuel**
 - **Environmental Control System**
- **OTHER DOD AIRCRAFT**
- **COMMERCIAL AIRLINERS**
- **SEA SYSTEMS**
- **LAND SYSTEMS**
- **BUILDINGS**
- **AUTOMOBILES**

TRAINING

INTERACTIVE DECISION TRAINING SCENARIO FOR USN DAMAGE CONTROL AND CBR-D DECISION TRAINING

Prepared by

**James J. McNeely
CBIAC
Chemical Biological Information Analysis Center
Battelle
2113 Emmorton Park Road
Edgewood, MD 21040**

Approved for Public Release: Distribution Unlimited

CONTEXT

- **SEA CONTROL AND TACTICAL NAVAL SURFACE FORCES**
 - **Naval Interdictions**
 - **Operate in Littoral Zones**
 - **Losses to a Minimum**
- **NBC ENVIRONMENT LIKELY**
 - **Proliferation**
 - **Increased use Scenarios**

Prepared by: James J. McNeely

CBIAC - 2

IAC TASK

- **WHAT**
 - **Interactive Damage Control Scenario Presentation System (DECAID)**
- **WHY**
 - **Risk Management Essential in CBR Environments**
 - **Increased Burdens**
 - **Competing Demands**
 - **Training Shortfall -- Integration of CBR Defense with other Damage Control Functions**
- **WHO**
 - **U.S. Naval Training Systems Center**

IAC METHODOLOGY

- **DEVELOP DAMAGE CONTROL DECISION TASKS AND RISK MANAGEMENT DILEMMAS**
- **DEVELOP DECAID SCENARIOS**
 - **Fire**
 - **Flood**
 - **Chemical Attack**
 - **Combinations**
- **DEVELOP DECAID RULE BASE USING INPUT FROM SUBJECT MATTER EXPERTS (SMES)**
- **DEVELOP INTERACTIVE DEMONSTRATION**
- **REVIEW BY NAVY USERS**

SUMMARY OF DATA

- **DEVELOPED**
 - **Scenarios**
 - **Interface Features**
 - **Controls, Displays, etc**
 - **Rules**
 - **Firemen, crew, event**
 - **Software (Primarily in C)**
- **CONDUCTED DEMONSTRATIONS**

RESULTS

- **SUCCESSFUL "6.2" DEMONSTRATION OF CONCEPT**
 - **Instructors of Navy Advance CBR Course**
 - **Surface Warfare Officer School**

Prepared by: James J. McNeely

CBIAC - 6

CONSEQUENCE

- **PRODUCT INTEGRATED INTO NAVY TRAINING COURSE**
- **USN PURSUING ADDITIONAL DEVELOPMENT**

WATERFOWL MORTALITY IN EAGLE RIVER FLATS, ALASKA

Presented by

**Peter D. Smallidge
CECRL-ORTA**

Authored by

**Dr. Charles H. Racine, CECRL-RE
U.S. Army Cold Regions Research and Engineering Laboratory
72 Lyme Road
Hanover, New Hampshire 03755-1290**

Approved for Public Release: Distribution Unlimited

CONTEXT

- **DOD MILITARY MISSIONS / FUNCTIONS**
 - Training
 - » General military training - artillery
- **ARMY MODERNIZATION STRATEGY**
 - Optimize readiness and training
 - » Maximize existing soldier skills

Prepared by: P. D. Smallidge

IAC ERF-1

IAC TASK / BASIC INFORMATION PRODUCT

- **BACKGROUND - 1990**
 - Eagle River Flats (ERF) 6th ID(L) Artillery Training Area closed due to long-term (10 years) waterfowl mortality
 - Cause of waterfowl mortality unconfirmed
 - 6th ID(L) forced to seek alternative training sites
- **IAC PRODUCT FOCUS**
 - Literature search on causes of waterfowl mortality
 - Review of previous studies
 - Survey of data analysis techniques

SUMMARY OF FINDINGS

- **PREVIOUS STUDIES (1982 - 1989)**
 - **Mortality primarily among dabbling ducks**
 - **Evaluations of sediment, water, and tissue samples**
 - **No laboratory studies of animals conducted**
 - **No indication of avian diseases or pesticides**
 - **Munition residues identified as probable cause of mortality (data inconclusive)**
 - **Initial test for phosphorous in 1983**
 - **No suitable tissue tests for explosives**

Prepared by: P. D. Smallidge

IAC ERF-3

SUMMARY OF FINDINGS

- **1990 STUDY**
 - **Focus on munition**
 - **Review of munitions used in ERF**
 - **Identified need for more intensive data collection**
 - » **GRASS GIS software**
 - » **Extensive water and sediment sampling for explosives**
 - **2, 4 DNT evaluation**
 - » **Identified toxicity test**
 - » **Mortality characteristics not consistent**
 - » **2, 4 DNT limited to EOD area**
 - **White phosphorous evaluation**
 - » **Found in all waterfowl samples from ERF**
 - » **Found in sediments of waterfowl ponds**
 - » **Laboratory studies match field observations**

CONSEQUENCES

- **WHITE PHOSPHOROUS IDENTIFIED AS CAUSE OF WATERFOWL MORTALITY**
- **LONG-TERM STORAGE OF WHITE PHOSPHOROUS IN ERF SEDIMENTS LIKELY**
- **PROPOSED ALTERNATIVE WINTER TRAINING SCENARIO TO 6TH ID(L)**
- **FOLLOW-ON STUDIES OF OTHER ARMY TRAINING AREAS**

BOTTOM LINE
SAVINGS TO ARMY \$22.4 MILLION

Prepared by: P. D. Smallidge

IAC ERF-5



CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER (CSERIAC) PRODUCTS & SERVICES

Presented by

**Donald Dreesbach
AL/CFH/CSERIAC**

**Bldg. 248
2255 H Street**

Wright-Patterson AFB, OH 45433-7022



ARMY NAVY AIR FORCE NASA FAA NATO

ADVANCED HUMAN SYSTEM INTERFACE DESIGN IN CONTROL ROOMS

- Task Overview & Project History
- Shortcomings of Scientific and Technical Information
- Subject Matter Reviewed
- CSERIAC's Review and Analysis Services
- Results of CSERIAC's Efforts
- Consequences of CSERIAC's Efforts
- Applications





PROJECT OVERVIEW AND HISTORY

- **CSERIAC and the Nuclear Regulatory Commission**
 - » Human Systems Interface Design Review Guideline (NUREG/CR-5908)
- **Project History**
 - » Document review process



SHORTCOMINGS OF SCIENTIFIC AND TECHNICAL INFORMATION

- **Shortcomings of Scientific and Technical Information,
Control Rooms Revisited:**
 - » **Changing technology**
 - » **Research gaps**
 - » **Advances in human factors research**





ARMY NAVY AIR FORCE NASA FAA NATO

SUBJECT MATTER REVIEWED BY CSERIAC

- **Human factors and control room design**
 - » **Display and Control Technologies**
 - » **Automation, Intelligent Aids, and Human Error**
 - » **Nuclear Power Plant Control Room Integration**



ARMY NAVY AIR FORCE NASA FAA NATO

CSERIAC REVIEW & ANALYSIS SERVICES

- Purpose
- Procedure
- Content
- Synthesis



RESULTS OF CSERIAC's EFFORTS

- **Reviews & Analyses Final Reports:**
 - » Display and Control Technologies
 - » Automation, Intelligent Aids, and Human Error
 - » Nuclear Power Plant Control Room Integration



ARMY NAVY AIR FORCE NASA FAA NATO

CONSEQUENCES OF CSERIAC'S EFFORTS

- Project Evaluation
- Further Study
- Update:
 - » Advanced Human Systems Interface Design Review Guideline
 - » The design of future control facilities



ARMY NAVY AIR FORCE NASA FAA NATO

APPLICATIONS

- **Benefits to the design of control facilities:**
 - » Extensive review of display control technologies
 - » Expanding upon research and applications of human factors in automation
 - » Expanding upon research and applications of artificial intelligence
 - » Expanding upon research in the area of human error
 - » Expanding upon research in the area of system integration



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CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER (CSERIAC) PRODUCTS & SERVICES

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HUMAN FACTORS ISSUE IN PERSONNEL TRAINING: POTPOURRI

- CSERIAC support of Department of Defense personnel training
 - Training Issues for Aircraft Automation
 - The Effects of Overtraining/Overlearning on Levels of Stress



STATE-OF-THE-ART HUMAN FACTORS TECHNICAL INFORMATION

- **Exploration of literature to support defense research for the development of training programs**
 - Identify research on automation and crew member training
 - Review the issues related to automatic responses in humans



SUPPORTING INNOVATIVE RESEARCH

- **CSERIAC helped to identify:**
 - Research for training crew members to interact with automation
 - Literature for the development of automaticity in personnel





CSERIAC SEARCH & SUMMARY SERVICES

- **Definition**
- **Procedure**
- **Purpose**
- **Scope**



RESULTS OF CSERIAC's EFFORTS

- **Training Issues for Aircraft Automation**
- **The Effects of Overtraining/Overlearning on Levels of Stress**





CONSEQUENCES OF CSERIAC's EFFORTS

- CSERIAC provided a firm foundation on which these researchers could develop new training programs.



ARMY NAVY AIR FORCE NASA FAA NATO

APPLICATIONS

- **Military**
- **Industry**



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CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER (CSERIAC) PRODUCTS & SERVICES

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HUMAN FACTORS IN THE DESIGN OF SYNTHETIC ENVIRONMENTS

- **Task Overview**
- **Project Scope**
- **Subject Matter Addressed**
- **CSERIAC Search & Summary Services**
- **Results of CSERIAC's Efforts**
- **Consequences of CSERIAC's Efforts**
- **Applications**



HUMAN FACTORS IN THE DESIGN OF SYNTHETIC ENVIRONMENTS

- **Definition**
- **Benefits**
- **Components**
- **Goals**
- **Results of CSERIAC's Efforts**
- **Consequences of CSERIAC's Efforts**
- **Applications**



HUMAN FACTORS IN THE DESIGN OF SYNTHETIC ENVIRONMENTS: TASK OVERVIEW

- **CSERIAC support of the Small Business Innovative Research
Program**
 - » Intelligent Information Presentation for Helmet Mounted Displays in
Synthetic Environments
 - » Force Tactile Feedback for Virtual Reality Environments
 - » Interaction with 3-D "Virtual" Environments





ARMY NAVY AIR FORCE NASA FAA NATO

STATE-OF-THE-ART HUMAN FACTORS TECHNICAL INFORMATION: PROJECT SCOPE

- Exploration of literature to support research for innovative concepts to solve defense-related scientific or engineering problems.
 - » Explore the presentation of tactical information
 - » Review how humans use tactile feedback in manipulating controls and displays
 - » Investigate how humans interact with 3-D virtual environments



SUPPORTING INNOVATIVE RESEARCH: SUBJECT MATTER ADDRESSED

- **CSERIAC identified:**
 - Research on the presentation of information for Helmet Mounted Displays
 - » Pilot information load
 - » Information usage
 - » Hardware constraints
 - Literature on force tactile feedback
 - Information for the creation of natural and realistic environments.



CSERIAC SEARCH & SUMMARY SERVICES

- Definition
- Procedure
- Purpose
- Scope



ARMY NAVY AIR FORCE NASA FAA NATO

RESULTS OF CSERIAC's EFFORTS

- Intelligent Information Presentation for Helmet Mounted Displays in Synthetic Environments
- Force Tactile Feedback for Virtual Reality Environments
- Interaction with 3-D "Virtual" Environments



CONSEQUENCES OF CSERIAC's EFFORTS

- CSERIAC provided a firm basis so small businesses could meet the research needs of the Department of Defense.



ARMY NAVY AIR FORCE NASA FAA NATO

APPLICATIONS

- There are few limitations to the scope of CSERIAC's Research. Although the information is intended for use in aviation settings, the results can be applied to most research and development for synthetic environments.

COMPUTERS & SOFTWARE COMMUNICATIONS NETWORKING

Prepared by

Ernest Smart

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **COMPUTERS & SOFTWARE**

- High performance computing systems providing orders of magnitude improvements in Modeling & Simulation

- **COMMUNICATIONS NETWORKING**

- The timely, reliable, and secure production and worldwide dissemination of information using shared communications media and common hardware and application software, organized/managed through established standards and protocols in support of Training, Military Operations, and Research, Development, & Acquisition (RDA)

TWSTIAC PRODUCTS

- **INFORMATION ON ADVANCED APPLICATIONS OF DISTRIBUTED SYSTEMS AND NETWORKING TECHNOLOGY**
 - **Catalog of program applications**
 - **DIS Test Bed**
 - **IEEE DIS Standards & Protocols**
- **DIS EDUCATION / WORKSHOPS**
 - **Standards Workshops**
 - **User Application Workshops**
 - **Computer Generated Forces (CGF) Workshops**

METHODOLOGY

- **VARIETY OF METHODS USED, INCLUDING ...**
 - Survey of key Users / Developers
 - Analysis based on expert panel, peer review, & technical assessments
 - Research on entity representation & alternative networking
- **APPROACH: TRADITIONAL MIXED WITH NEW IDEAS**
 - Applications of DELPHI technique to establish priorities
 - Electronic "Town Meetings" focused on special interest groups
 - Expert seminars organized in conjunction with national conferences; e.g., I/ITSEC, AUSA
 - User workshops geared to change the way Users think and introduce new paradigms for leveraging efforts

SUMMARY OF DATA

- **DATA COLLECTION CATEGORIES**
 - Expert Points of Contact
 - “LESSONS LEARNED” on research findings
 - Key research initiatives sorted by requirements
 - Standards and protocols for networked applications
 - Service and DOD regulatory requirements
 - Key Industry members in the communications field
- **INTERESTING CHARACTERISTICS**
 - Inconsistency in data elements across Users
 - “FEAST OR FAMINE” population of data across areas
 - Lack of configuration control on data
 - Breadth & diversity of Users
 - Volume & quantity of data

RESULTS OF DATA ANALYSIS

- **FINDINGS**

- Condition of networking is of such diversity that linkages can only be accomplished via standard protocols
- Methods of sharing networking solutions are not widely publicized
- Interservice solutions are rare

- **SUMMARY OF TECHNICAL RECOMMENDATIONS**

- Policy on standards in applications must be developed to recognize variety of previous applications
- Standards of data, database design, and horizontal integration are needed to meet the operational needs of Users

ARMS CONTROL

**BIO TECHNOLOGY: A SURVEY OF SEVEN
TECHNOLOGIES TO IDENTIFY CLOSTRIDIUM
BOTULINUM AND BACILLUS ANTHRACIS**

Prepared by

**Dr. Salvatore Bosco, Dr. Leo Laughlin, Milton Miles and James McNeely
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2113 Emmorton Park Road
Edgewood, MD 21040**

Approved for Public Release: Distribution Unlimited

CONTEXT

- **BIOLOGICAL WARFARE CONVENTION TECHNICAL DISCUSSIONS**
- **IDENTIFY TECHNICAL ISSUES ASSOCIATED WITH DEVELOPMENT OF VERIFICATION INITIATIVES**

BIO TECHNOLOGY TASK

- **WHY**
 - **Technical Exchanges**
 - International Assertions on BWC Verifiability
 - Claims of Equipment Capabilities
 - Provide Common Denominator for Comparison of Technical Specifications
 - Need to Define Technical Terminology
 - Capture Current Information on Rapid-Paced Technological Advances
 - Provide Technical Information to Negotiators who have Little Technical Background
 - Technical and Policy Experts use same "Sheet of Music"
 - Need to Address Real-World Problems
 - False Positive (vs False Negatives)
 - Masking Issues/Interferences
- **WHO**
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- **WHAT**
 - **Technical Review of Leading Edge Technologies for Identification of Botulinum and Anthrax**

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- **SCOPE TO WORKABLE SET OF TECHNOLOGIES FOR PROOF OF CONCEPT**
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- **THOROUGHLY REFERENCED**
- **EXPERT REVIEW AND EVALUATION OF TECHNICAL/MEDICAL LITERATURE**

SUMMARY OF DATA

- **OVERVIEW OF CUTTING-EDGE TECHNOLOGIES**
- **REVIEW OF APPLICABILITY TO SPECIFIC IDENTIFICATION**
- **EXPERIENCED SCIENTISTS FOR EVALUATION**
- **MATRIX PRESENTATION ALLOWS FOR EASY EXTENSION TO OTHER DISEASE-CAUSING ORGANISMS OF INTEREST**

RESULTS OF DATA ANALYSIS

- **BW TECHNOLOGY DOCUMENT PROVIDED U.S. NEGOTIATORS WITH DATA TO EFFECTIVELY RESPOND TO PROPOSALS FOR BWC VERIFICATION REGIMES**

CONSEQUENCES

- **DOCUMENT PROVIDED TO U.S. BWC TECHNICAL REPRESENTATIVES**
- **EXTRACTS OF DOCUMENT DISTRIBUTED TO INTERNATIONAL DELEGATES**

RELEVANCE TO OTHER USERS

- **WORLD HEALTH ORGANIZATION**
- **INDUSTRY**
- **NATIONAL INSTITUTE OF HEALTH**
- **CENTER FOR DISEASE CONTROL**
- **ACADEMIA**

CHEMICAL WARFARE COUNTER PROLIFERATION COMPUTERIZED DECISION AID

Prepared by

**Dr. Susan Brown, Thomas D. Sizemore and James J. McNeely
CBIAC
Chemical Biological Information Analysis Center
Battelle
2113 Emmorton Park Road
Edgewood, MD 21040**

Approved for Public Release: Distribution Unlimited

CONTEXT

- **ARMS CONTROL**
 - **Counter Proliferation**
 - **Chemical Weapons**
 - **Resources and Technologies Necessary to Develop Chemical Weapons**

Prepared by: Dr. Susan Brown, et al

CBIAC - 2

IAC TASK

- **WHY**
 - **Intelligence Analysts Need Tools for Timely Analysis of Potential Chemical Warfare Production Sites**
- **WHAT**
 - **Develop Computerized Decision Aid to Depict Visual Signatures of Chemical Warfare Agent Production Sites based on Technology**
- **WHO**
 - **U.S. Army Foreign Science and Technology Center (A Component of the U.S. Army's Intelligence and Security Command)**

IAC METHODOLOGY

- **USE BASIC CHEMISTRY AND PRODUCTION STANDARDS**
- **BUILD DATABASES**
- **DEVELOP/OBTAIN AND INTEGRATE ANALYSIS AND SPECIAL DESIGN SOFTWARE TO APPLY ENGINEERING STANDARDS AND MANIPULATE DATA**
- **DEVELOP GRAPHICAL USER INTERFACE (GUI) TO DEPICT VISUAL SIGNATURES OF CHEMICAL WARFARE AGENT PRODUCTION SITES**

SUMMARY OF DATA

- **CHEMICAL REACTION PROCESS DATA TO INCLUDE**
 - **Reaction Chemistry**
 - **Feedstocks**
- **ENGINEERING PRACTICES AND TECHNOLOGIES OF COUNTRIES OF INTEREST**
 - **Equipment**
 - **Feedstocks (available/unavailable)**
 - **Infrastructure**
 - **Weaponization Capabilities**
- **QUANTITIES OF AGENT PRODUCED**

RESULTS

- **OPERATIONAL PROTOTYPE DEVELOPED AND DEMONSTRATED**
 - **Nerve Agents**
 - **Multi - Country Data**

Prepared by: Dr. Susan Brown, et al

CBIAC - 6

CONSEQUENCES

- **FILLS CRITICAL CAPABILITY VOID**
- **IMPROVES TIMELINESS AND QUALITY OF SITE ASSESSMENTS**
- **PROVIDES CAPABILITY TO EVALUATE ALTERNATE SCENARIOS**
- **PROVIDES CAPABILITY TO ACCOUNT FOR CHANGE IN**
 - **Production Levels**
 - **Technological Capabilities**
 - **Engineering Practices**

OTHER POTENTIAL APPLICATIONS

- **TRAINING AND PREPARATION OF INSPECTION TEAMS**
- **DESIGN ENGINEERS IN CHEMICAL PROCESS INDUSTRY**

COMMERCIAL PRODUCTS FROM DEMILITARIZATION OPERATIONS

Prepared by

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CONTEXT

- **CHEMICAL WARFARE CONVENTION**
- **IMPLEMENTATION OF NUNN-LUGAR**
- **SUPPORT OF RUSSIAN DEMILITARIZATION OPERATIONS**

Prepared by: Salvatore Bosco, et al

CBIAC - 2



IAC TASK

- **WHY**
 - **Identify Processes for the Conversion of CW to Commercial Products**
 - **Evaluate Russian Initiatives for Conversion of Lewisite to Recover Arsenic**
- **WHO**
 - **Office of the Assistant Secretary of Defense (OTASD (AE) (CM))**
- **WHAT**
 - **Report**

IAC METHODOLOGY

- **REVIEW LITERATURE**
- **EVALUATE PROPOSED PROCESS STEPS**
- **ASSESS MARKET FOR COMMERCIAL ARSENIC**

Prepared by: Salvatore Bosco, et al

CBIAC - 4



SUMMARY OF DATA

- **IDENTIFY PATENTS, STUDIES ON POTENTIAL COMMERCIAL APPLICATIONS FOR CW DEMIL PRODUCTS**
- **IDENTIFICATION OF POTENTIAL PATHWAYS FOR CONVERSION OF LEWISITE TO ARSENIC**
- **ANALYSIS OF VALUE OF HIGH-PURITY ARSENIC**

RESULTS OF DATA ANALYSIS

- **PROVIDED LIST OF POSSIBLE CW COMMERCIAL PRODUCTS**
- **ANALYZED POSSIBLE STEPS/LIMITS FOR LEWISITE-ARSENIC CONVERSION PROCESS**

Prepared by: Salvatore Bosco, et al

CBIAC - 6

CONSEQUENCES

- **PROVIDED OTASD WITH INFORMATION ON VIABILITY OF RUSSIAN PROPOSAL**
- **INPUT TO NUNN-LUGAR IMPLEMENTATION**

Prepared by: Salvatore Bosco, et al

CBIAC - 7

RELEVANCE TO OTHER USERS

- **INDUSTRY**
- **OPCW**
- **OTHER CW-POSSESSING NATIONS**

Prepared by: Salvatore Bosco, et al

CBIAC - 8

STRATEGIC FORCES AND ARMS CONTROL: INFRARED SIGNATURE COMPUTER CODES

Presented by:

**Rodney C. Anderson
Director**

**Infrared Information Analysis Center
Environmental Research Institute of Michigan**

**Ann Arbor, MI 48113
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anderson@dmso.dtic.dla.mil**

Approved for Public Release: Distribution Unlimited

CONTEXT

- Infrared threat systems are becoming more capable as focal plane science and signal processing capability advance. Signature modification is a robust counter to these advances.
- IRIA has a series of codes that may be used to assess the infrared signature of objects, propagation through the atmosphere, and detection performance
- Key technologies: Environmental effects, materials and processes, design automation
- Missions:
 - Strategic Forces (manned bombers)
 - Tactical Air Forces (land and sea based)
 - o Reconnaissance
 - o Deep strike
 - o Air superiority
 - Domestic Technology Transfer

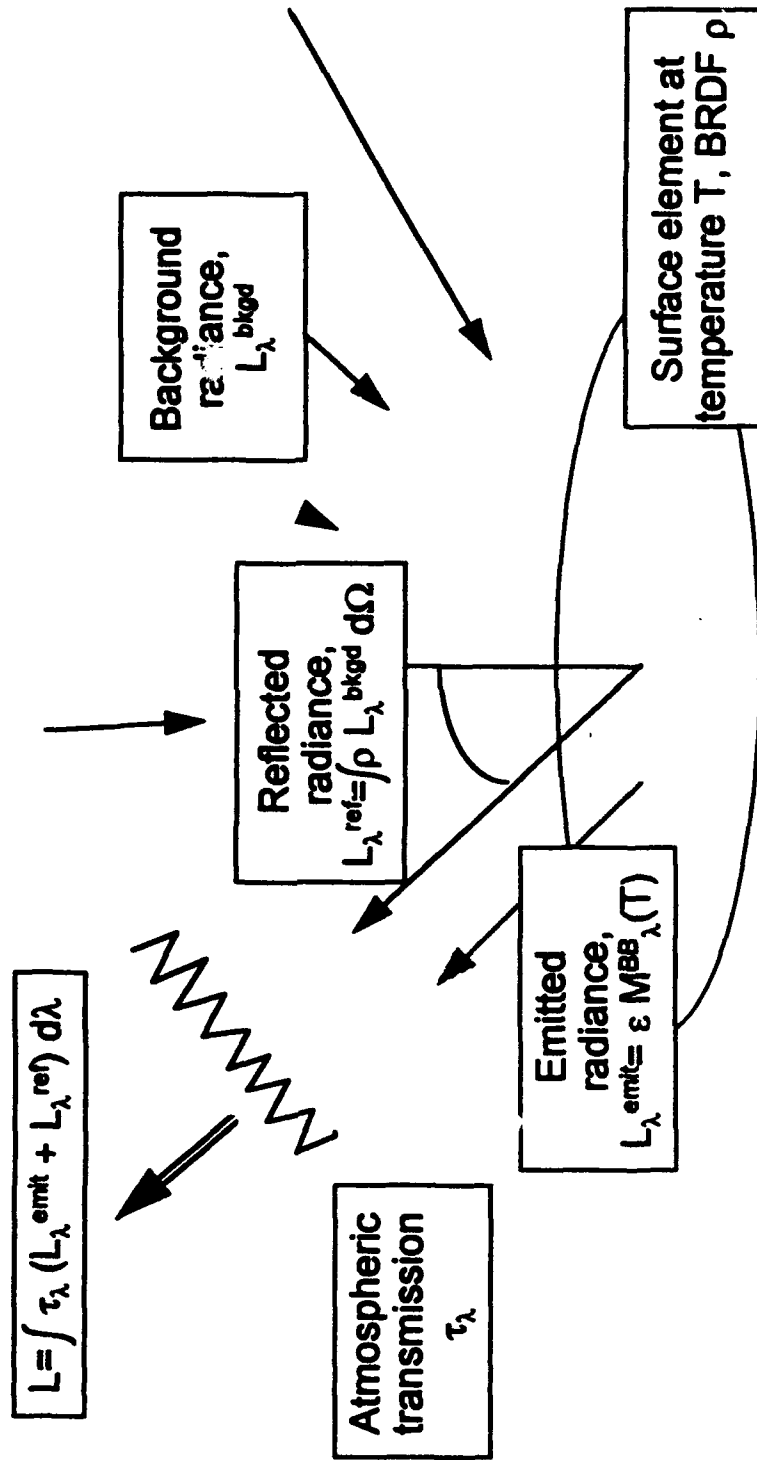
IRIA SIGNATURE PREDICTION PRODUCTS

- **TARSIS infrared signature code**
 - computes source, target, apparent radiance contrast
 - sensor performance
- **APART atmospheric properties code**
 - Similar to LOWTRAN
 - fully correlated band computation
 - computes background radiance
- **CREEP**
 - R&D
 - first principles coating reflectance predictions
 - unique capability
 - unclassified, but restricted distribution (preapproval required)

IAC METHODOLOGY

- **CODE DEVELOPMENT**
 - Third party development
 - Government owned (or rights)
 - Modifications and improvements by ERIM
- **DISTRIBUTION**
 - Source code, object code, test cases, and documentation included.
 - Codes available for variety of machines
 - o VAX
 - o UNIX workstation (SPARC, Indigo, IRIS)
 - o PC (some codes)
 - Source code not available for CREEP

- SIGNATURE PREDICTIONS
- TARSIS AND APART ADDRESS OVERALL VEHICLE AND ENVIRONMENT
- CREEP FOR COATING PREDICTIONS (BRDF)

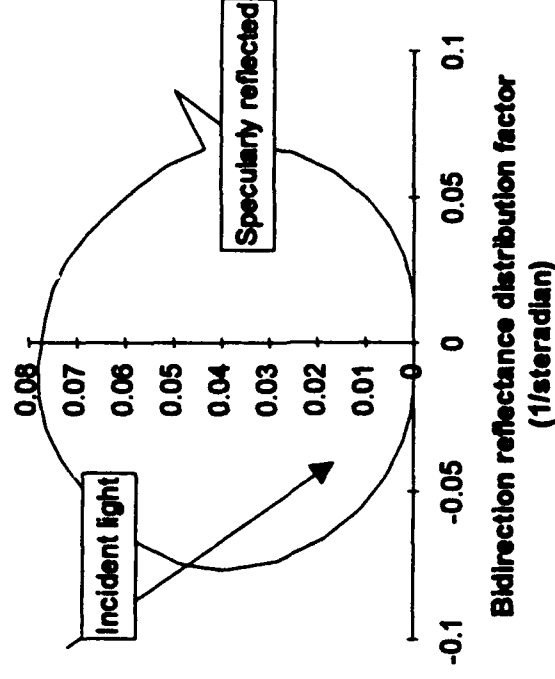


CREEP RESULTS

- **CREEP ARCHITECTURE**
 - Adding /doubling method used for radiative transport
 - Scattering
 - o Closed form Mle scattering
 - o Henyey-Greenstein
 - o Specified scattering phase function
 - Surface reflectance
 - o Specular (Fresnel)
 - o Computed
 - coherent/ incoherent domains
 - two scale lengths
- **CREEP VERIFICATION AND ASSESSMENT COMPLETED**
 - Code appropriate for comparison of coating designs
 - Supporting data required for absolute predictions

CONSEQUENCES

- **EXTENSIVE DISTRIBUTION**
 - Government
 - Industry
- **PROVIDES A CAPABILITY NOT PREVIOUSLY AVAILABLE**
 - Flexible first principles approach
 - Can be used in other spectral regimes
 - Wide application



TASK RELEVANCE

- **CREEP CODE RELEVANT TO:**
 - **Sensor performance**
 - **Mission analysis**
 - **Coating design**
 - **Dual use (product appearance)**
 - o **automotive**
 - o **other consumer industries**
- **CREEP METHODOLOGY RELEVANT TO:**
 - **Environmental assessment**
 - **Terrain typing**
 - **Atmospheric modeling (clouds and other optically thick media)**

STRATEGIC FORCES AND ARMS CONTROL: "OPEN SKIES" SUPPORT

Presented by:

**Rodney C. Anderson
Director**

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**Ann Arbor, MI 48113
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Approved for Public Release: Distribution Unlimited

CONTEXT

- OPEN SKIES TREATY
 - 27 + Nations
 - Mutual overflights using similar sensor equipment
 - o Panoramic and framing cameras
 - o Infrared line scanner
 - Sensor must be certified to specific performance levels
 - “Confidence builder” for more stringent arms control agreements
- IRIA SUPPORT TO US DELEGATION

IRIA SUPPORT

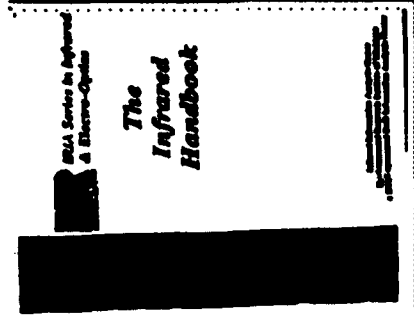
- **INCLUDES ASPECTS OF PASSIVE ELECTRO-OPTICAL SENSORS WITHIN SENSOR KEY TECHNOLOGY**
- **IRIA SUPPORT FOCUS**
 - **Consult with US delegation**
 - **Review sensor performance prediction and calibration with foreign representatives**

IRIA Methodology

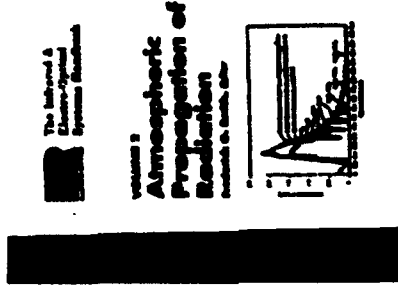
- **EVALUATE SENSOR PERFORMANCE PREDICTION APPROACH**
- **DEVELOP SENSOR RESOLUTION LIMITS**
- **USE HANDBOOK DATA TO SUPPORT**

TASK SUMMARY

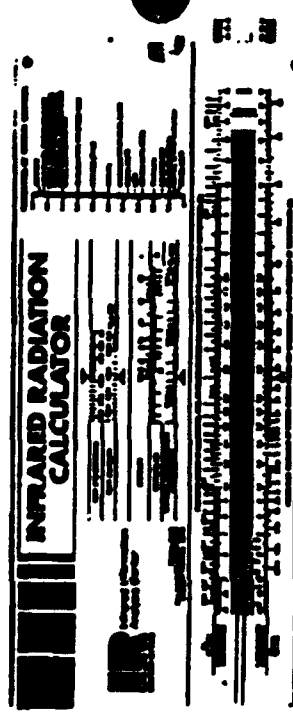
- IR HANDBOOK
USED FOR
BACKGROUND
MEASUREMENTS



- IR/EO SENSOR
HANDBOOK USED
FOR
ATMOSPHERICS



- IR SLIDE RULE
USED FOR FIRST-
ORDER ANALYSIS



RESULTS OF DATA ANALYSIS

- **DELEGATION REACHED CONSENSUS ON SENSOR APPROACH**
- **SUPPORT PROVIDED FOR PLENARY MEETINGS**

CONSEQUENCES

- **COST BENEFITS**
 - Agreement reached on sensor calibration procedures
 - Allows sensor performance assessment with rudimentary test apparatus
- **PERFORMANCE BENEFIT**
 - Rapid assessment of sensor performance allows completion of missions within treaty mandated times
 - Simple but accurate assessments contribute to mutual confidence building among signatories

TASK RELEVANCE

- **HANDBOOK DATA RELEVANT TO VARIETY OF TASKS**
- **ARMS CONTROL SUPPORT REQUIRES FIRST ORDER ANALYSIS IN MANY CASES**

DUAL USE

BIO TECHNOLOGY: A SURVEY OF SEVEN TECHNOLOGIES TO IDENTIFY CLOSTRIDIUM BOTULINUM AND BACILLUS ANTHRACIS

Prepared by

**Dr. Salvatore Bosco, Dr. Leo Laughlin, Milton Miles and James McNeely
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- **BIOLOGICAL WARFARE CONVENTION TECHNICAL DISCUSSIONS**
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Prepared by: Salvatore Bosco, et al

CBIAC - 2

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CBIAC - 2

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- **WHY**
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CBIAC - 2

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CBIAC - 8

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RELEVANCE TO OTHER USERS

- **INDUSTRY**
- **OPCW**
- **OTHER CW-POSSESSING NATIONS**

WATERFOWL MORTALITY IN EAGLE RIVER FLATS, ALASKA

Presented by

**Peter D. Smallidge
CECRL-ORTA**

Authored by

**Dr. Charles H. Racine, CECRL-RE
U.S. Army Cold Regions Research and Engineering Laboratory
72 Lyme Road
Hanover, New Hampshire 03755-1290**

Approved for Public Release: Distribution Unlimited

CONTEXT

- **DOD MILITARY MISSIONS / FUNCTIONS**
 - Training
 - » General military training - artillery
- **ARMY MODERNIZATION STRATEGY**
 - Optimize readiness and training
 - » Maximize existing soldier skills

IAC TASK / BASIC INFORMATION PRODUCT

- **BACKGROUND - 1990**
 - Eagle River Flats (ERF) 6th ID(L) Artillery Training Area closed due to long-term (10 years) waterfowl mortality
 - Cause of waterfowl mortality unconfirmed
 - 6th ID(L) forced to seek alternative training sites
- **IAC PRODUCT FOCUS**
 - Literature search on causes of waterfowl mortality
 - Review of previous studies
 - Survey of data analysis techniques

SUMMARY OF FINDINGS

- **PREVIOUS STUDIES (1982 - 1989)**
 - Mortality primarily among dabbling ducks
 - Evaluations of sediment, water, and tissue samples
 - No laboratory studies of animals conducted
 - No indication of avian diseases or pesticides
 - Munition residues identified as probable cause of mortality (data inconclusive)
 - Initial test for phosphorous in 1983
 - No suitable tissue tests for explosives

Prepared by: P. D. Smallidge

IAC ERF-3

SUMMARY OF FINDINGS

- **1990 STUDY**
 - Focus on munition
 - Review of munitions used in ERF
 - Identified need for more intensive data collection
 - » GRASS GIS software
 - » Extensive water and sediment sampling for explosives
 - 2, 4 DNT evaluation
 - » Identified toxicity test
 - » Mortality characteristics not consistent
 - » 2, 4 DNT limited to EOD area
 - White phosphorous evaluation
 - » Found in all waterfowl samples from ERF
 - » Found in sediments of waterfowl ponds
 - » Laboratory studies match field observations

CONSEQUENCES

- **WHITE PHOSPHOROUS IDENTIFIED AS CAUSE OF WATERFOWL MORTALITY**
- **LONG-TERM STORAGE OF WHITE PHOSPHOROUS IN ERF SEDIMENTS LIKELY**
- **PROPOSED ALTERNATIVE WINTER TRAINING SCENARIO TO 6TH ID(L)**
- **FOLLOW-ON STUDIES OF OTHER ARMY TRAINING AREAS**

BOTTOM LINE
SAVINGS TO ARMY \$22.4 MILLION



ARMY NAVY AIR FORCE NASA FAA NATO

CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER (CSERIAC) PRODUCTS & SERVICES

Presented by

**Donald Dreesbach
AL/CFH/CSERIAC**

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ARMY NAVY AIR FORCE NASA FAA NATO

ADVANCED HUMAN SYSTEM INTERFACE DESIGN IN CONTROL ROOMS

- Task Overview & Project History
- Shortcomings of Scientific and Technical Information
- Subject Matter Reviewed
- CSERIAC's Review and Analysis Services
- Results of CSERIAC's Efforts
- Consequences of CSERIAC's Efforts
- Applications



PROJECT OVERVIEW AND HISTORY

- CSERIAC and the Nuclear Regulatory Commission
 - » Human Systems Interface Design Review Guideline (NUREG/CR-5908)
- Project History
 - » Document review process



ARMY NAVY AIR FORCE NASA FAA NATO

SHORTCOMINGS OF SCIENTIFIC AND TECHNICAL INFORMATION

- Shortcomings of Scientific and Technical Information,
Control Rooms Revisited:
 - » Changing technology
 - » Research gaps
 - » Advances in human factors research



SUBJECT MATTER REVIEWED BY CSERIAC

- **Human factors and control room design**
 - » Display and Control Technologies
 - » Automation, Intelligent Aids, and Human Error
 - » Nuclear Power Plant Control Room Integration



CSERIAC REVIEW & ANALYSIS SERVICES

- Purpose
- Procedure
- Content
- Synthesis



RESULTS OF CSERIAC's EFFORTS

- **Reviews & Analyses Final Reports:**
 - » **Display and Control Technologies**
 - » **Automation, Intelligent Aids, and Human Error**
 - » **Nuclear Power Plant Control Room Integration**



CONSEQUENCES OF CSERIAC's EFFORTS

- Project Evaluation
- Further Study
- Update:
 - » Advanced Human Systems Interface Design Review Guideline
 - » The design of future control facilities





APPLICATIONS

- **Benefits to the design of control facilities:**
 - » Extensive review of display control technologies
 - » Expanding upon research and applications of human factors in automation
 - » Expanding upon research and applications of artificial intelligence
 - » Expanding upon research in the area of human error
 - » Expanding upon research in the area of system integration



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AFIMY NAVY AIR FORCE NASA FAA NATO

INTEGRATED MAINTENANCE INFORMATION SYSTEM (IMIS): DEFINED

- Human Factors issues in the design of the IMIS -
Portable Maintenance Aid
 - IMIS is the maintenance technician's interface with:
 - » Maintenance Information Workstations
 - CAMS (Maintenance Records)
 - SBSS (Supply)
 - CEMS (Engine Monitoring)
 - » Aircraft interface panels



ARMY NAVY AIR FORCE NASA FAA NATO

IMPROVED TACTICAL AIRCRAFT MAINTENANCE THROUGH HUMAN FACTORS: IMIS BENEFITS

- **IMIS will improve tactical aircraft maintenance by:**
 - Reducing maintenance downtime
 - Preventing false removals of system components
 - Increasing the productivity of inexperienced technicians
 - Providing more accurate and complete maintenance data



ARMY NAVY AIR FORCE NASA FAA NATO

TECHNICAL INFORMATION AT THE TECHNICIAN'S FINGERTIPS: IMIS COMPONENTS

- CSERIAC supported the collection, review, and analysis of human factors technical information for the design of handheld computers in maintenance environments.
- IMIS provides centralization for maintenance information including:
 - » Technical Orders
 - » Supply and Management Data
 - » Training Data
 - » Aircraft Maintenance Records
 - » Flight Data
 - » Aircraft Diagnostics



AFIMY NAVY AIR FORCE NASA FAA NATO

HUMAN COMPUTER INTERACTION ON THE FLIGHTLINE: IMIS GOALS

- **Improved maintenance performance**
- **Develop new concepts and technologies**
 - » Develop new ideas for improving maintenance
 - » Test ideas with few dollars before commitment
 - » Develop enabling technologies
- **Focus on the End-User**
 - » Develop systems from technician's point of view
 - » Conduct field evaluations with maintenance technicians
- **Transition results to system implementors**
 - » Weapon system SPOs (F-22, F-16, JSTARS, C-17, B-2)
 - » Computer-aided acquisition and logistics support (CALS)



RESULTS OF CSERIAC'S EFFORTS

- **Specification for IMIS interface**
 - **Common user interface specification**
 - » Reviewed of Human System Interface issues
 - » Recommended design constraints of the portable maintenance aid
 - **Technical information presentation specification**
 - » MIL-M-87268 general content, style, format, user interaction requirements
 - » Identified user-centered information needs
 - **Lessons Learned as they apply to DoD programs**



CONSEQUENCES OF CSERIAC's EFFORTS

- CSERIAC's information support permitted timely and accurate:
 - » Specification of:
 - User interface needs
 - IMIS hardware
 - Information content of maintenance tasks
 - Access structures
 - Style and format of information
 - » Identification of:
 - Alternative technologies
 - Human System Interface analysis of requirements for maintenance applications
 - » Development of:
 - Specification/manual
 - Lessons learned document



IMIS APPLICATIONS

- **IMIS will be applied to the maintenance of:**
 - F-22
 - F-16
 - B-2
 - JSTARS
 - Army M-1
- **Technology transfer**

**DATA & ANALYSIS CENTER
FOR SOFTWARE (DACs)**

DACS TECHNICAL REPORTS

Prepared by

**James J. Reed
Data & Analysis Center for Software
Kaman Sciences Corporation
258 Genesee St., Suite 103
Utica, NY 13502**

Approved for Public Release: Distribution Unlimited

DACS TECHNICAL REPORTS

- **THE DACS PRODUCES AND DISTRIBUTES A VARIETY OF SOFTWARE ENGINEERING AND SOFTWARE TECHNOLOGY REPORTS OF INTEREST TO MEMBERS OF THE SOFTWARE ENGINEERING COMMUNITY.**
- **DoD Key Technologies: Computer Software / Computers**
 - o **Software and Systems Engineering**
- **DoD Science & Technology Thrust - 7**
 - o **Technology for Affordability**
- **DoD Military Missions/Functions**
 - o **Technology Transfer**

DACS - 2

Prepared by: James J. Reed

DACS TECHNICAL REPORT TOPIC AREAS

- **SOFTWARE REUSABILITY**
- **DISTRIBUTED DATABASE TECHNOLOGY**
- **ARTIFICIAL NEURAL NETWORKS**
- **SOFTWARE ANALYSIS & TEST TECHNOLOGIES**
- **AN OVERVIEW OF OBJECT ORIENTED DESIGN**
- **SOFTWARE QUALITY**
- **SOFTWARE PROTOTYPING & REQUIREMENTS ENGINEERING**
- **FAST PROTOTYPING OF SOFTWARE - THE SPIRAL MODEL**
- **FORMAL METHODS**
- **NON-ADA TO ADA LANGUAGE CONVERSIONS**

DACS - 3

Prepared by: James J. Reed

TECHNICAL REPORT PREPARATION

- **TOPICS SELECTED BASED ON LEVEL OF INTEREST TO MEMBERS OF THE DACS USER COMMUNITY**
- **TECHNICAL REPORT TYPES**
 - **State-of-the-Art Reports**
 - **Critical Reviews/Technology Assessments**
 - **Data Analysis Reports**
 - **Technical Area Task Related Reports**
- **REPORT PRODUCTION**
 - **DACS Staff Members**
 - **Kaman Sciences Staff**
 - **DACS Subcontractor Team**

DACS - 4

Prepared by: James J. Reed

TECHNICAL REPORT SUMMARY

- **SOARs EXAMINE SOFTWARE ENGINEERING TOPICS WHICH INCLUDE LEADING EDGE TECHNOLOGY AND PROVEN TECHNOLOGY OF INTEREST TO OUR USERS**
- **CR/TAs ARE MORE NARROWLY FOCUSED ON A TECHNOLOGY INSTANTIATION**
- **DATA ANALYSIS REPORTS EXAMINE DATA OR ONE OR MORE ASPECTS OF DATA (i.e., SOFTWARE RELIABILITY, etc.)**
- **TECHNICAL AREA TASK RELATED REPORTS DISCUSS ASPECTS OF THE TASK PERFORMED OR SPECIFIC TECHNOLOGIES EXAMINED OR EMPLOYED IN THE TASK**

DACS - 5

Prepared by: James J. Reed

TECHNICAL REPORT RESULTS

- **USER CURRENCY IN THE LATEST SOFTWARE ENGINEERING TECHNOLOGIES, TOOLS, METHODS, AND MEASURES**
- **TECHNOLOGY TRANSITION/TRANSFER**
- **DISCUSSION OF THE TECHNOLOGY TRENDS AND DIRECTIONS**
- **EXPANSION OF DACS STAFF CAPABILITIES INTO THE STATE-OF-THE-ART AND STATE-OF-THE-PRACTICE**
- **TEAM APPROACH TO PRODUCTION ALLOWS US TO OBTAIN REPORTS FROM LEADING SCIENTISTS & ENGINEERS**

DACS - 6

Prepared by: James J. Reed

FUTURE TOPIC AREAS

- **A SURVEY OF SOFTWARE ENGINEERING ENVIRONMENTS**
- **TOOLS FOR SOFTWARE MAINTENANCE**
- **A SUMMARY OF DISTRIBUTED PROCESSING SYSTEMS**
- **A REVIEW OF SOFTWARE MEASUREMENT TOOLS**
- **A MANAGER'S GUIDE TO VERIFICATION & VALIDATION**
- **SOFTWARE DEVELOPMENT RISK MANAGEMENT**
- **ADVANCED ARCHITECTURES FOR DISTRIBUTED SYSTEMS**
- **SOFTWARE PROCESS METRICS AND MEASURES**

Prepared by: James J. Reed

DACS - 7

**DATA & ANALYSIS CENTER
FOR SOFTWARE (DACs)**

**OPEN ARCHITECTURE SYSTEMS FOR
PROCESS AUTOMATION (OASYS)**

Prepared by

**James J. Reed
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Kaman Sciences Corporation
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Approved for Public Release: Distribution Unlimited

OPEN ARCHITECTURE SYSTEMS FOR PROCESS AUTOMATION (OASYS) TOOLSET

- **THE OASYS TOOLSET FOR PROCESS AUTOMATION IS A SUITE OF SOFTWARE TOOLS USED FOR THE RAPID PROTOTYPING AND LOW-COST MAINTENANCE OF WORKFLOW PROCESS SYSTEMS.**

- **DoD Key Technologies: Computer Software / Computers**
 - o **Software and Systems Engineering**
 - o **Human - Computer Interface**
 - o **Software for Parallel & Heterogeneous Distributed Systems**
- **DoD Science & Technology Thrust - 7**
 - o **Technology for Affordability**
- **DoD Military Missions/Functions**
 - o **Technology Transfer**

DACS - 2

Prepared by: James J. Reed

OASYS TOOLSET PROJECT INFORMATION

- **DEVELOPED TO AUTOMATE PRODUCTION OF TECHNICAL DATA PACKAGES FOR WEAPON SYSTEM PROCUREMENT**
- **WORK PACKAGE TRACKING THROUGH DOCUMENT SYSTEMS**
- **MULTI-USER, DISTRIBUTED, HETEROGENEOUS SYSTEMS**
- **OPEN SYSTEM ENVIRONMENT OPERATIONS**
- **ROUTING, PROCESSING & TRACKING OF FORMS & IMAGES**
- **REPLACEMENT FOR HIGH MAINTENANCE SYSTEMS**
- **SPONSOR: US ARMY ARDEC
PICCATINNY ARSENAL, NJ
AND
USAF ROME LABORATORY
Griffiss AFB, NY 13441**

Prepared by: James J. Reed

DACS - 3

OASYS TOOLSET DEVELOPMENT METHODS

- **OASYS TOOLSET METHODOLOGY EMPLOYED**

- **COTS RDBMS And 4GL Application Manager**
- **Object Oriented Design**
- **Client/Server Architecture**

- **PROCESS AUTOMATION APPROACH**

- **Open Systems Environment**
- **Requirements Engineering**
- **Rapid Prototyping**
- **User Training**
- **User Maintained**

DACS - 4

Prepared by: James J. Reed

PROCESS AUTOMATION SYSTEM FEATURES

- **FULL AUDITING OF WORK PACKAGE ACTIONS**
- **FLEXIBLE ROUTING OF FIXED & AD HOC OPTIONS**
- **ELECTRONIC SIGNATURES WITH MULTIPLE SECURITY**
- **FORMS ON PLAIN WHITE BOND WITH SCRIPT SIGNATURES**
- **IMPORT/EXPORT DATA FROM OTHER PLATFORMS**
- **“BUBBLE-UP” MANAGEMEMENT & EMAIL**
- **PROBLEMS & RESOLUTIONS**
- **PAPERLESS SYSTEM**

DACS - 5

Prepared by: James J. Reed

OASYS TOOLSET RESULTS IN TDP TRACKER

- **TDP TRACKER GOALS**
 - **Link Multiple Users in Distributed System**
 - **Reduce TDP Processing Time From Over 190 to Less Than 60 Days**
 - **Reduce Cost/Improve Quality**
 - **Reduce Paper Volume**
 - **Reduce System Maintenance**
- **TDP TRACKER RESULTS**
 - **> 700 Users at Dover, NJ, Rock Island, IL, and Aberdeen, MD**
 - **Processing Time < 28 Days**
 - **Cost Savings of > \$400,000.00 Per Day**
 - **All Electronic System**
 - **Maintained By One Government Employee**

DACS - 6

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ADDITIONAL APPLICATIONS

- **USA WATERVLIET ARSENAL - ACQUISITION SYSTEM**
- **DTIC - IAC PROGRAM TECHNICAL AREA TASK TRACKER**
- **USA LIFE CYCLE SOFTWARE ENGINEERING CENTER
UPGRADE 10 YEAR OLD ACQUISITION SYSTEM**
- **KAMAN AND OTHER CORPORATE CUSTOMERS IN
MANUFACTURING / PRODUCTION ENVIRONMENTS**
- **ANY GOVERNMENT OR COMMERCIAL PROCESS
AUTOMATION SYSTEM REQUIRING DOCUMENT/DATA
MANAGEMENT**

DACS - 7

Prepared by: James J. Reed



DAM BREAK ANALYSES

Presented by

**Mark R. Jourdan
CEWES-HE-E
Hydraulic Engineering
Information Analysis Center
Waterways Experiment Station
Vicksburg, MS 39180**

Approved for Public Release: Distribution Unlimited

OBJECTIVE

- **DOD KEY TECHNOLOGY EFFORT - ENVIRONMENTAL EFFECTS**
 - **The Study, Modeling, and Simulation of Terrestrial Environmental Effects**
 - **Natural and Man-Made Effects**
 - o **Examples Include**
 - **Flooding by rainfall-runoff**
 - **Flooding by reservoir release**
 - **Flooding by dam breach**
 - **Impact of the Environment on Military Vehicles, Weapons, and Maneuvers**



EFFECTS OF DAM BREACH

- **OBSTACLE CREATION**
- **HYDROPOWER AND NAVIGATION**
- **DOWNSTREAM STRUCTURES AND FACILITIES**
- **DECREASED THREAT OF ENEMY FLOODING**

DAM BREAK ANALYSIS

- **COLLECT DAM AND TERRAIN CHARACTERISTICS**
- **PREDICT BREACH SIZE**
 - **Dependent on Breach Mechanism**
 - **Dependent on Dam Type**
- **TACTICAL DAM ANALYSIS MODEL (TACDAM)**
 - **Peak Depth**
 - **Time to Peak Depth**
 - **Time to Flood and Deflood**
 - **Area Inundation**

RESULTS OF DATA ANALYSIS

- **EFFECTS OF FLOODING ON VEHICLES**
- **IMPASSABLE AREAS INDICATED**
- **TIMING OF RESULTANT FLOOD AVAILABLE**

CONSEQUENCES

- **SAVINGS IN TERMS OF PRODUCTIVITY**
 - Quick Analysis Tool
 - Ability to Evaluate Many Alternatives
- **IMPROVEMENT IN MILITARY CAPABILITY**
 - Evaluate Combat Effectiveness
 - Plan Maneuver of Forces
- **RESULTS INCORPORATED INTO OPERATION PLANNING**

RELEVANCE TO OTHER USERS

- SECONDARY USERS
 - Logistics
 - Special Operations
- STANDARD MODEL (TACDAM) DEVELOPED
 - Possible Users Include
 - o U.S. Army Terrain Teams
 - o FEMA
 - o State Agencies

**HIGH TEMPERATURE MATERIALS PROPERTIES
ONLINE NUMERIC DATABASE CAPABILITY FOR
DUAL-USE TECHNOLOGY TRANSFER**

Prepared by

**Ronald H. Bogaard and Harold Mindlin
High Temperature Materials Information Analysis Center
CINDAS/Purdue University
West Lafayette, IN 47906-1398**

Approved for Public Release; Distribution is Unlimited

CONTEXT

- **SUPPORT TO:**
 - **DoD Military Mission/Function**
 - o **Dual-Use Technology Transfer**
 - o **Professional Military Education**
 - **DoD Key Technology Area**
 - o **Materials and Processes**
 - o **Sensors**
 - **DoD Science and Technology Thrust**
 - o **Technology for Affordability**
 - o **Advanced Land Combat**
- **OBJECTIVE**
 - **Electronic storage and dissemination of numeric data on advanced materials for both military and industrial applications**

HTMIAC BASIC INFORMATION PRODUCT

- **SUBSET OF DOD MILITARY MISSIONS**
 - **High Temperature Materials Properties (HTMP) database contributes to domestic technology transfer**
 - **Materials properties data and information are integral components of the military dual-use and domestic technology transfer missions**
- **HIGH TEMPERATURE MATERIALS PROPERTIES (HTMP) ONLINE NUMERIC DATABASE CAPABILITY**
 - **What: Develop an electronic database containing data and information on material properties**
 - **Who: Defense Technical Information Center (DTIC)**
 - **Form: Computerized database, online accessible (telephone line connection) from user's own personal computer or computer terminal**

HTMIAC METHODOLOGY

- **METHODOLOGY EMPLOYED**
 - **Data Collection:**
 - o Material property data within HTMIAC scope searched from open literature and analyzed for factors that influence property behavior
 - **Data Analysis:**
 - o Material processing
 - o Material characterization
 - o Property test method
 - o Material conditioning/environmental exposure
 - o Experimental variables
 - **Data Synthesis:**
 - o Basic unit of data and information is "data set"
 - o Design and creation of database file structure
 - o Design and creation of ancillary database files
 - o Design of data search strategies and creation of enabling software
 - o Implementation of online access
 - o Development of graphical display option

METHODOLOGY (continued)

- APPROACH FOLLOWED
 - Features of HTMP Online Numeric Database:
 - o Content of Database
 - Centralized source of scientific and technological data and information on high temperature materials properties
 - Materials include aerospace structural polymer-matrix composites, carbon/carbons and alloys, infrared detector materials, and coatings for optical components
 - o Computerization Aspects
 - Remote access, instant retrieval, electronic dissemination of data
 - Linkup is by personal computer/terminal, modem, and telephone/data line
 - Data and Information Sources:
 - o Material property data were captured from available open literature
 - New Information Created:
 - o Online capability enables fully electronic dissemination of data and information

SUMMARY OF DATA

- DATA COLLECTED

- Property data for high temperature materials of current interest:
 - o Properties include thermophysical, thermoradiative, ablative, mechanical, electronic, and optical
 - o Materials include aerospace structural polymer matrix composites, carbon/carbons and alloys, infrared detector materials, and coatings for optical system components
 - o Pertinent information includes: material characterization, material processing, test method, and material conditioning
 - o Current statistics show 18,600 data sets for 1,010 specific material names

- Interesting Characteristics:

- o When viewed as a centralized data resource, the database contains a remarkable variety of information
- o The database is the only online-accessible, computer-searchable database of its size and type

RESULTS OF DATA ANALYSIS

- **FINDINGS RESULTING FROM ANALYSIS OF THE COLLECTED DATA**
 - The amount of data is significant, the number of materials and properties is surprisingly large, and the variety of experimental variables is remarkable
 - A database of this type can become a primary means for electronic dissemination of numerical data and information from DoD laboratory sources to user communities anywhere
- **SUMMARY OF TECHNICAL RECOMMENDATIONS**
 - Send us a letter request, and we will send you a login and password

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS PRODUCT?**
 - **A centralized source of property data and information on high temperature materials was made available for remote, online access to qualified users**
 - **Financial Benefits to DoD**
 - o **Savings from having a large, single-source data and information resource readily available**

RELEVANCE TO OTHER USERS

- **RELATED SUBSTANTIVE PROBLEMS FOR WHICH THE HTMP ONLINE DATABASE WOULD BE RELEVANT**
 - Any materials and processing DoD key technology area activity will be interested in accessing a single-source numeric data resource
- **ANALOGOUS PROBLEMS FOR WHICH THE HTMP ONLINE DATABASE WOULD BE RELEVANT BECAUSE OF THE DATA/METHODOLOGY USED**
 - Methodology used for collection, analysis, and compilation of data and information can be used for any materials and properties



NONDESTRUCTIVE/NON-INTRUSIVE SENSORS FOR MANUFACTURING PROCESS CONTROL

Prepared by

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Austin, Tx. 78746**

Approved for Public Release: Distribution Unlimited

Prepared by: Gary W. Carriveau

NTIAC - 1

CONTEXT

- **NONDESTRUCTIVE EVALUATION AND INSPECTION OF MATERIALS AND SYSTEMS HAS BEEN IDENTIFIED AS A DOD CRITICAL TECHNOLOGY**
- The objective of this task is to investigate the application of nondestructive/non-intrusive sensors for manufacturing and material process control. This includes sensors used in monitoring the process result (product) and the state-of-health of the fabrication equipment used to produce the product.

Prepared by: Gary W. Carriveau

NTIAC - 2

NTIAC TASK FOCUS

- NONDESTRUCTIVE AND NON-INTRUSIVE SENSORS AND "SMART" SENSOR SYSTEMS ARE URGENTLY NEEDED FOR IN-PROCESS CONTROL OF MANUFACTURING LINES, REAL-TIME CONTROL OF MATERIAL PROCESSING, AND IN-SITU MONITORING OF THE CONDITION AND PERFORMANCE OF PROCESSING EQUIPMENT
- APPLICATION OF THESE SENSOR SYSTEMS WILL RESULT IN INCREASED PRODUCTIVITY, REDUCED MATERIAL WASTE, REDUCED EQUIPMENT DOWN TIME, AND IMPROVED EQUIPMENT MAINTENANCE PROCEDURES
- NTIAC was requested by the Army Research Laboratory, Materials Directorate, Material Evaluation Branch to investigate the use of NDE sensors for advanced manufacturing in support of the Manufacturing Technology Program
- Assistance is to be provided in the form of a technology assessment, the results are to be used in strategic planning

NTIAC METHODOLOGY

- **BIBLIOGRAPHIC SEARCH**
- **SITE VISITS TO ASSESS CURRENT TECHNOLOGY**
- **DEFINITION OF APPLICABLE TECHNOLOGIES**
- **IDENTIFICATION OF TECHNOLOGY GAPS**
- **ASSISTANCE IN COORDINATION OF EFFORTS BY DOD, OTHER GOVERNMENT, ACADEMIA AND INDUSTRY**

Prepared by: Gary W. Cariveau

NTIAC - 4

SUMMARY OF DATA

- **BIBLIOGRAPHIC SEARCH**
- **ANALYSIS AND SYNTHESIS OF CITED DATA**
- **SITE VISITS**
- **WORKSHOPS/CONFERENCES**

ANALYSIS RESULTS

- FINAL TECHNICAL REPORT IN THE FORM OF A TECHNOLOGY ASSESSMENT
- REQUIREMENTS ANALYSIS FOR NDE SENSORS USED IN MANUFACTURING
- IDENTIFICATION OF POTENTIAL APPLICABLE SENSOR TECHNOLOGIES
- IDENTIFICATION AND DEFINITION OF SENSOR TECHNOLOGY GAPS

Prepared by: Gary W. Carriveau

NTIAC - 6

EXPECTED RESULTS AT THE CONCLUSION OF THIS EFFORT

- **INPUT FOR MANUFACTURING TECHNOLOGY STRATEGIC PLANNING**
- **DEFINITION OF NDE SENSOR REQUIREMENTS FOR MANUFACTURING**
- **REQUIREMENT ANALYSIS AND RECOMMENDED SUPPORT FOR SENSORS TO FILL TECHNOLOGY GAP**
- **PROFESSIONAL CONFERENCE PRESENTATION/PUBLICATION**
- **ASSISTANCE IN ORGANIZING AN INTERNATIONAL MEETING ON MECHANICAL FAILURE PREVENTION**

Prepared by: Gary W. Carriveau

NTIAC - 7

RELEVANCE TO OTHER USERS

- THE RESULTS WILL BE USEFUL TO ANYONE INVOLVED IN MANUFACTURING PROCESSES
- APPLICATIONS WILL IMPROVE PRODUCTIVITY AND REDUCE MATERIAL AND OPERATING COSTS
- PROVIDES ADDITIONAL INFORMATION FOR NDE SENSOR DEVELOPMENT

CONCURRENT ENGINEERING SERIES

**(DoD S&T THRUST: TECHNOLOGY FOR
AFFORDABILITY)**

Prepared By

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Director
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Rome, NY 13440-6916**

Approved for Public Release: Distribution Unlimited

RAC PRODUCT STRATEGY

- **TARGET MANAGERS**

- **Awareness**
- **Impact on programs**
- **Basics**
 - o **Terminology**
 - o **Tasks**
 - o **Subtasks**
- .
- .
- .

- **TARGET DESIGNERS**

- **Impact of new technologies**
- **Design practices/guidelines**
- **Ability to trade-off alternatives**

- **TARGET R/M/Q PRACTITIONERS**

- **Procedural guides**
- **Data to support analyses**
- **Quick guides/automated tools**

PRODUCT RELEVANCE

- **DOD S&T THRUST: TECHNOLOGY FOR AFFORDABILITY**
- **PRODUCT FOCUS**
 - **Stresses concurrent engineering impacts on R&M**
 - **Leverage automation of R&M techniques**
 - **Products to date:**
 - o **Introduction to CE**
 - o **Failure Mode Effect and Criticality Analysis**
 - o **Fault Tree Analysis**
 - o **Worst Case Circuit Analysis**
 - o **Reliability/Maintainability Software Tools**
- **PRODUCT IMPACT**
 - **Make application of R&M technologies more cost effective in CE process with end result lower life-cycle cost**

"RELIABILITY/MAINTAINABILITY SOFTWARE TOOLS (RMST-93)" SAMPLE RECORD

Name: RPP (Reliability Prediction Program)

Description:

Implementation of part stress reliability prediction MIL-HDBK-217 for systems limited in size only by disk storage space. Standard features include: provisions for system structure input and editing, component data input and editing, access to part data libraries, defaults for component reliability calculations, part/assembly/system failure rate calculation, generation of twelve predefined reports on part/ assembly/ system, utilities for file and computer system management.

Hard/Software Req.: IBM PC, UNIX, Macintosh, NeXT, Sun SPARC Workstations

Interface Capabilities: Powertronic's MPP, FME, and SRP

Supplier: Powertronic Systems, Inc.

13700 Chef Menteur Hwy.

New Orleans, LA 70129

Demo Avail. & Price: Free

Phone: (504) 254-0383

Software Price: \$ 1,700

'RELIABILITY/MAINTAINABILITY SOFTWARE TOOLS (RMST-93)" SAMPLE TABLE

| Product Name | IBM PC | VAX | UNIX | Mac | Apollo | Sun | Other | Page # |
|---|--------|-----|------|-----|--------|-----|-------|--------|
| 217 Predicts | | | | X | | | | 13 |
| ARM E (Advanced Reliability Modeling) | X | X | X | | | | | 13 |
| ARM F (Advanced Reliability Modeling) | X | X | X | | | | | 13 |
| Bellcore ARPP | X | X | X | | | | | 21 |
| Belstress | X | X | | | | | | 21 |
| Computer Aided Reliability Program (CARP) | X | | | | | | | 13,19 |
| DORMACALC 4.0 | X | | | | | | | 25 |
| FNPRD-3 (Nonelectronic Parts Reliability Data) | X | | | | | | | 21 |
| Hardstress | X | X | | | | | | 21 |
| MDR-21A Data | X | | | | | | | 22 |
| MECHREL (Mechanical Reliability Prediction Program) | X | | | | | | | 27 |
| MRP (Mechanical Reliability Prediction Program) | X | | | | | | | 27 |
| Milstress | X | X | | | | | | 14 |
| PC COMMERCIAL | X | | X | | | | | 22 |
| PC MIL-HDBK-217F | X | | | | | | | 14 |
| PC STRESS Analysis | X | | | | | | | 14 |
| PREL | X | | | | | | | 22 |

CURRENT RAC PRODUCTS

DATA PUBLICATIONS **6**

APPLICATION GUIDES **11**

COMPONENT PUBLICATIONS **7**

SPECIALIZED SERIES:

-- **Concurrent Engineering** **5 ***

-- **Reliable Applications of Components** **3**

-- **Total Quality Management Series** **3**

SOFTWARE/DATABASES **7**

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